Modern Foundry Layout

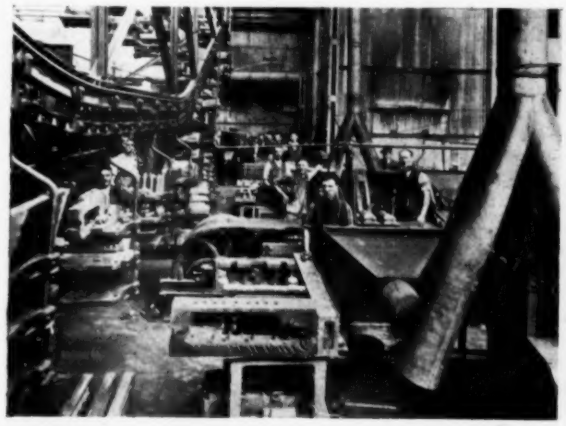
Further Developments in the Recently Constructed Foundry of Messrs. Morris Motors Ltd.

MODERN thought in foundry layout has developed considerably, and new foundries that have been equipped during recent years have incorporated many advantages resulting from progress. Amenities that for long have been appreciated in the design of other workshops and factories are gradually being recognised as having as much importance to the workers in the foundry; the need for adequate ventilation, and a fuller use of natural light, are factors that have long been overlooked. It is questionable whether any workshop or factory suffers from the want of good ventilation so much as the foundry; the peculiar nature of the work necessitates special arrangements being made for the rapid removal of gases to ensure a good circulation of air. It is true that much attention has been directed to the need for effectively reducing the laborious work by the introduction of machines, but it is perhaps as important from a productive point of view to improve the working conditions by ensuring good air and light. It is interesting to note that Messrs. Morris Motors, Ltd., have given these factors proper consideration when designing their recently constructed foundry at Coventry.

Originally this foundry was designed to produce the castings for 1,000 four-cylinder engine units per week, and while modifications have taken place as a result of the production of the minor and six-cylinder models, operations are carried on on a similar basis. The design of this plant is unusual in this country, and as alterations have been made in the method of production, the important features of the design can be profitably considered. It can be justly said that this foundry conveys the principles of advanced development for a specialised class of work.

The enormous expansion in the work of this company necessitated the construction of a new foundry, and a site occupying about forty acres was obtained for the purpose at Coventry. The structure which has been built upon this site was designed jointly by the plant and buildings department of Morris Engines and the foundry manager, Mr. A. Smith. It is worthy of note that arrangements have been made for possible expansion, to be effected without in any way interfering with production from the plant now in operation. The building embraces seven bays, each 25 ft. wide, and the roofs are so disposed and glazed that they give a north light. The glass being used the full

Core-making Section.



Blacking Drying Stove and Storage Pendulum Conveyor.

Core Inspection and Blacking Department.

General Moulding Bay.

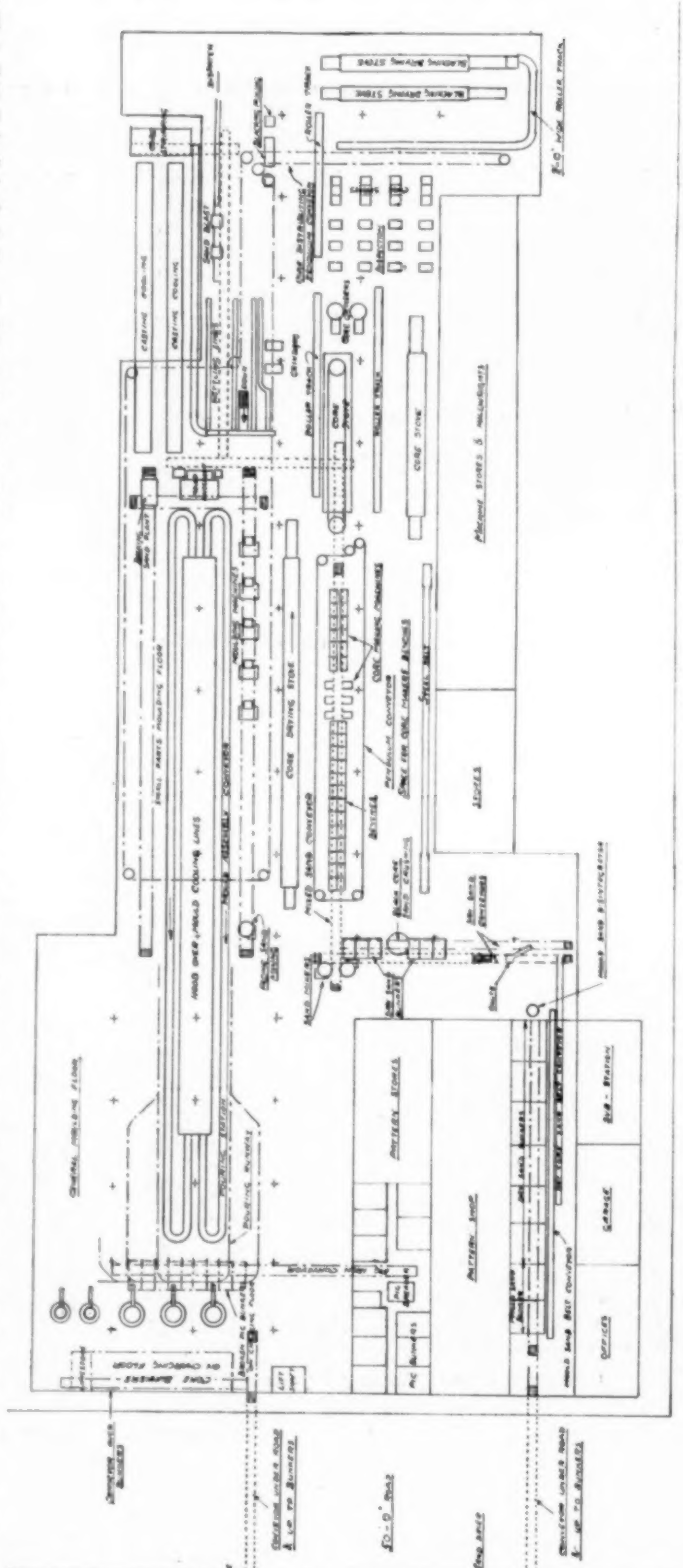
length of the building and forming the whole of one side of each roof gives an excellent light in any part of the foundry. Artificial light supplied is electric, and the lamps are so arranged that they are directed to give the fullest advantage to the workers. The heating and ventilation are provided for by a series of ducts arranged below the floor level. In winter air is drawn through steam-heated coils, while in warmer weather fresh air is circulated. For this purpose five fans are installed: three are each driven by a 25-h.p. motor, each of the remaining two being driven by a 12-h.p. motor. These fans are capable of changing the volume of air in the foundry twice in the course of an hour.

The whole plant has been arranged to reduce the laborious nature of the work so common to the majority of foundries, and conveyors of various types have a predominating influence on the layout. The various conveying arrangements were built and installed by Herbert Morris, Bagshawe and Co., New Conveyor Co., and the Steel Band Conveyor Co. The work in connection with the installation was done in close collaboration with Mr. Smith and the works engineering staff.

The foundry has been designed on the straight-line principle in the sense that raw materials enter at one end and the finished castings are transported from the other end to a machine shop built adjacent to the foundry. The sidings by which the raw materials are conveyed are connected to the main line of the L.M.S. Railway, and are worked by a petrol locomotive. These sidings are separated from the main building by a 50-ft. ferro-concrete road, but underground tunnels and an overhead crane, for conveying the various materials necessary, leave the roadway entirely unobstructed.

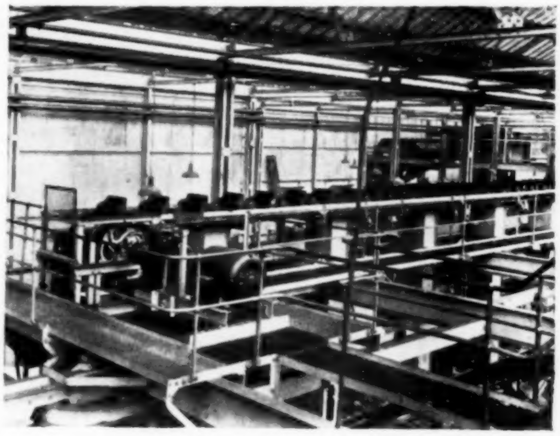
The conveying problem is tackled in a very ingenious manner. Both core and moulding sands are delivered in wagons, and a special underground conveyor transports them to their respective storage bins. The discharging is done under cover, and an August rotary sand-drier is located adjacent to the wagon, so that the sand which passes through it will discharge by gravity into the conveyor. Originally this drier was inside the foundry building, but it is now recognised to be more advantageous to dry the core sand at once before being conveyed. Leighton Buzzard is used exclusively for core sand, and it is fed into the rotary drier direct from the wagon. This is the only hand operation performed. The rotary drier is coke-fired, and is arranged on an incline, so that the sand passes to a screen from the drying chamber. The screen is integral with the drier, and the sand passing through it is deposited in a tunnel conveyor of the bucket type, which transports it to the storage bins. The same conveyor is used to transport the moulding sand to its storage bunker. It is of interest to note that a Bromsgrove sand is used for this purpose.

The transportation of the pig iron is effected by means of an electric crane of 4 tons capacity. It is of the overhead type, and carries a 12½-cwt. magnet. Suspended from the crane is a cradle of 25-cwt. capacity. The cradle is loaded by means of the magnet, and this arrangement allows a larger quantity to be carried, in addition to providing a safety device when metal is being carried on the magnet. The pig iron is stored in eleven concrete bunkers lined with wood, each having a capacity of 25 tons. The magnet is used for charging the cradle, and subsequently



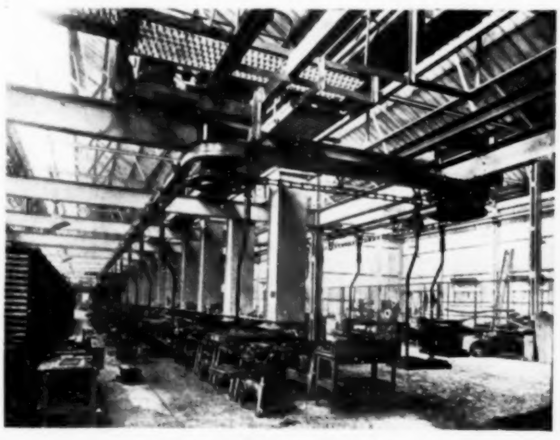
General Layout of the Morris Foundry.

discharging into the respective bunkers, according to the grade of pig iron. Adjacent to the storage bunkers is an improved type of pig breaker, by which the pigs are broken into four pieces. This pig breaker is capable of dealing with pig iron at the rate of 5 to 6 tons per hour. The broken pig iron is carried by a chute to an elevator, which raises it to the cupola-charging platform, and delivers it to storage bins convenient for charging.



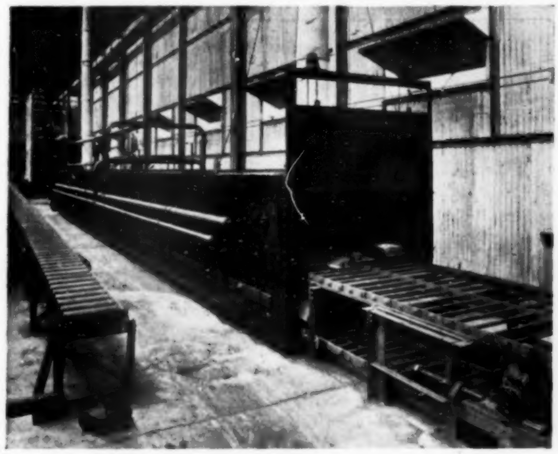
Bagshawe Scraper Conveyor.

From the same siding coke is passed through a Fraser and Chalmers side discharge tippler of Marshall design. From the tippler it is discharged into a receiving hopper, the bottom of which is fitted with a long shaker feeder. Control of the tippler is effected by two motors; a high-speed motor gives the power for the first operation of the wind, while a slow-speed motor takes charge of the tipping operation of the wind. This slow-speed motor can be electrically varied in speed to allow for any change of tipping time between 3·6 and 20 mins. The whole arrangement has been designed to minimise breakage. The coke is delivered through a shaker feed into a bucket conveyor, which travels under the roadway and raises it to deliver down a chute which feeds on to a screen chute, and all coke over 3 in. is discharged to another bucket conveyor, fitted with a tripper, into a coke bunker of 50 tons capacity. The same conveyor system handles the limestone, for which the screen bars are covered by hinged plates. The limestone is delivered to a bunker, having a capacity of 20 tons, which is adjacent to the coke bunker.



Overhead Pendulum Conveyor by Bagshawe.

In the production of castings for the various parts comprising motor-engine units cores play an important part. In this foundry the system adopted, particularly in regard to the repetition work, involves more than the customary use of cores. The moulds are almost wholly formed with cores, but a distinction is made between those which form the exterior of the mould and the jacket, valve, cylinder cores, etc. Oil sand cores are used exclusively for the inner cores. The mixtures are prepared in two Rotoil mixers, which are placed adjacent to each other and near to the sand bunkers. The dried sand is drawn from the bunker by means of a measuring skip, which contains 4 cub. ft. of sand, and is fitted with drop-bottom device, so that sand can be dropped into either of the mixers. A proportion of reclaimed core sand is added to the new sand, together with the required measure of bond. The mixing machines work rapidly, enabling each to be discharged after 3 mins. of mixing, and the output of the pair of machines approximates to between 4 and 5 tons per hour. One man is capable of charging these mixers, so that they involve very little labour.



Gas-fired Core-drying Stove by Pneulec, Ltd.

Each mixer has a pneumatically controlled chute which discharges the mixed sand direct on to an elevator conveyor, serving bins which are placed between two lines of core-making machines.

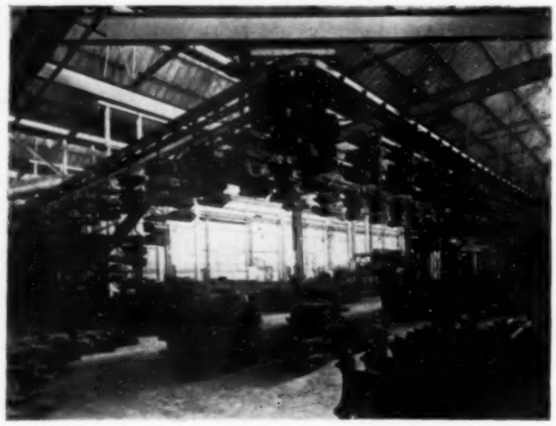
The core-shop is equipped with twenty-four hand roll-over machines and thirty benches, and the whole area is traversed by an overhead pendulum conveyor, which receives the cores as they are prepared and transports them to core ovens at a continuous speed of 20 ft. per minute. In view of the fact that oil sand cores are very fragile when green, the pendulum has been designed to take up vibration. They are carried from pairs of springs, and the trolleys are fitted with roller bearings.

Showing Cores on Band with Oven and Cooler in Distance.

Two gas-fired ovens receive the cores to be dried: one by August Muffle Furnaces, Ltd., 50 ft. × 9 ft. 6 in., is

fitted with a pendulum rack, the other is a continuous type by Pneulec, Ltd., 50 ft. × 4 ft. 9 in., which is operated by a chain grid installed by Morris Motors, Ltd. In these ovens the cores rest on carriers, which give free heat circulation, and movable bridges can be carried to accommodate a second tier of cores if necessary. After passing through the ovens, the cores pass to cooling racks and on to benches where they are examined and finally trimmed. A gravity conveyor carries the finished cores to a battery of blackwash benches, where they are sprayed with blacking and returned by conveyor to special drying ovens of similar design to the large core ovens, where they remain for about an hour at a temperature varying between 200° and 250° F.

Morris Pendulum conveying Cores from Core-drying Ovens. Cores being transferred to Conveyor.



Morris Pendulum Conveyor conveying Cores.

It will be noted that the inner cores are dried before any attempt is made to coat them with blackwash; there maining cores which form the mould proper are sprayed with blacking while they are green, and are consequently subjected to one baking operation. This is done in a Pneulec-type oven, 100 ft. × 4 ft. 3 in., equipped by Morris Motors, Ltd., with a continuous conveyor, which is gas-fired, and heated to a temperature of between 300° and 400° F. Formerly, when the moulds were prepared in boxes, the drying occupied between six and seven hours, and blacking was sprayed on after baking; with the use of cores, complete drying is accomplished in two or three hours, after which they are ready for assembly.

Combination Wind Belt Type Cupolas with Drop Branches from Belt to Tuyères.

Special boxes have been designed and cast to surround the assembled cores. The cores forming the bottom of the mould are first assembled to allow for the setting of the inner cores. The mould is subsequently built about these, the joints between the various outside cores sealed, and sand rammed between them and the moulding box. Runner and rises are arranged, the boxes clamped, and the completed moulds are conveyed from the assembling floor to the casting floor on a plate conveyor. The whole process of assembling and casting is carried on while on the conveyor. After being cast, the heads are broken, and, without being handled, the cast moulds continue to be carried by the conveyor through an exhaust chamber for exhausting gases and partial cooling of the castings. This exhaust chamber is 175 ft. long, and the fumes are exhausted by a fan operated by a 10-h.p. motor. The cast moulds, after passing through the exhaust chamber, are finally delivered to a shaking-out station, where they are transferred to a grid by means of a pneumatic hoist. The stipped castings are placed on another conveyor, by which they are slowly conveyed to the fettling station, where preliminary fettling is effected to facilitate further transport on a gravity roller track to the fettling department proper, where operations are carried out on team-work principles. The fettling department is consistent with the remainder of the plant. Two Luke and Spencer grinders, two overhead grinders, and two sand-blast cabins, together with pneumatic tools, constitute the plant.

It may be mentioned that when the castings are roughly cleaned at the shaking-out station sand is reclaimed, which is delivered by means of a shaker feeder to a scraper conveyor working below floor level, and finally elevated for delivery through a screen over a magnetic separator by the Rapid Magnetting Machine Co. Ltd., and falling into an August disintegrator, in which it receives the necessary water addition. Another disintegrator by Alfred Herbert Ltd. is also used for breaking-up new red sand and preparing it for use.

The melting plant is not the least interesting part of the

(*Continued on page* 83.)

Lead in Cast Brass and Bronze

By H. C. Dews.

LEAD is the most frequently occurring metal in brass and bronze, other than the copper, tin, and zinc essential to their composition. In cast alloys, comprising gunmetals, phosphor bronzes, manganese bronzes, and yellow brasses, the presence of at least a trace of lead is almost universal. Lead is present in high-grade engineering brasses and bronzes to the extent of from $\frac{1}{10}$ to 1%, and general castings ordinarily used for low-stressed parts frequently contain up to 5% lead. There is also a distinct though small class of copper alloys which contain large amounts of lead as an essential constituent. This comprises statuary bronze, leaded bearing bronze, and so on. Apart from these alloys, however, lead is a constituent not essential to the ordinary usage of brass and bronze, and the majority would function as well in service without any lead content. Its presence can only be explained, therefore, by reference to secondary considerations.

The suggestion that most cast brass and bronze might work, in service, quite as well without as with a small lead content, is not sufficient reason to regard lead uncompromisingly as an impurity to be eliminated, and to infer that its presence is harmful. This attitude is somewhat prevalent among engineers, and is due mainly to the lack of a full understanding of the function and behaviour of lead. There are also to be noticed in technical literature occasional claims made, with rather more enthusiasm than justification, for one or another outstanding improvement which lead is supposed to confer upon brass and bronze, and such overstatements, in time, naturally rebound to the discredit of lead.

From the commercial point of view, lead is often under suspicion simply because it is much cheaper than the other constituents of brass and bronze, and nefarious attempts at adulteration are thus often ascribed to manufacturers who desire to include a little lead in their alloys. Such a point of view is particularly unfortunate, because the inclusion of lead can often only be justified on account of its conferring manufacturing advantages, and these advantages are quite unconnected with the price of lead itself. Thus, in many cases a hasty elimination of lead may react to the buyer's disadvantage by greatly increasing the price at which his orders can be economically manufactured.

The suspicion with which lead is commonly regarded is reflected in many of the well-known specifications issued by official and public bodies. There are, for example, the two British Engineering Standards Association Specifications for cast brass. Specification No. 207 refers to brass ingots to be used for the manufacture of castings, and the other specification—No. 208—covers special brass castings. The two specifications are identical in regard to details affecting the composition and tests of the alloys. Both allow up to 3% or even 5% of any other metal than copper and zinc, according to the type of brass desired, but lead is expressly limited to 0·5% maximum. The manufacturer has full liberty to include in the brass large amounts of any impurity other than lead, provided, of course, that the mechanical tests are satisfied. Whatever may have been the disadvantages which were envisaged as following the inclusion of more than ½% lead, the drafting of the specification leads one to suppose that they were not liable to reflect harmfully on the strength properties.

There are also specifications for bronzes in which lead receives special attention. The best known probably is the Admiralty specification for gunmetal, and many authorities have followed the example set by the British Admiralty in steadfastly excluding lead from 88—10—2 and similar alloys. When Admiralty gunmetal, as it is now known, was first brought into general use about the beginning of this century the total impurities which included, but which did not specifically mention, lead had not to exceed ½%. Later, as some of the manufacturing advantages obtained by the inclusion of a small amount of lead were realised, it became customary to allow up to ½% lead in addition to minor impurities. The Admiralty chemists invariably still question lead content higher than ½%. The Air Board specification for 88—10—2 is more rigid, and calls for metal which shall contain no admixture of lead.

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The constitution of brass or bronze is entirely unaffected by lead, since it is practically insoluble both in the liquid and solid alloys. In the cast material, therefore, lead is present as more or less globular inclusions of structurally free pure metal, and the alloy itself crystallises in its normal fashion just as if no lead were present. When a piece of brass or bronze is polished during the preparation of a microsection, the free lead, which is very soft, is rubbed out of the surface and tiny holes are left in its place. When such a section is examined under the microscope the holes appear black, and the size and distribution of the black patches indicate the disposition of the lead. The typical appearance of a leaded bronze is shown in the microsection illustrated in Fig. 1. The lead takes up various forms according to the structure of the base alloy. It may be in the form of very fine films, finely disseminated particles, or even in large pools.

It has to be remembered that during the cooling of a brass or bronze casting the lead, on account of its insolubility, is liquid down to 327°C—long after the rest of the alloy has frozen. It takes up its position in the interstices of the brass or bronze crystallites the location of which depends upon the manner of the freezing of the alloy. In brass, for example, the rate of freezing, due essentially to the long freezing range of these alloys, has a particularly important effect on the crystal structure, and in consequence on the distribution of the lead. If the cooling rate is slow, there is a tendency towards the formation of large coarse crystals, during the growth of which the lead is pushed to the crystal boundaries, where it can agglomerate into massive pools. On the other hand, with very rapid cooling a finer crystallisation is induced, and the lead is trapped in fine particles throughout the dendritic structure.

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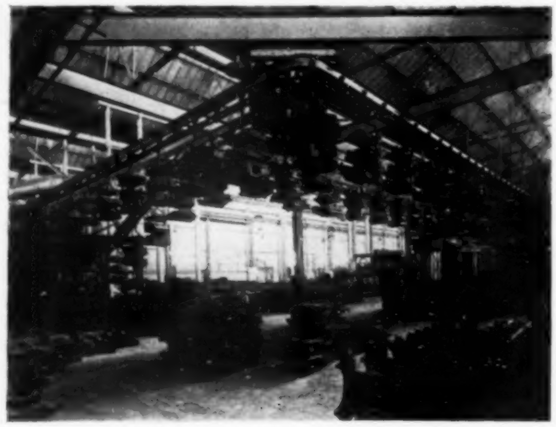

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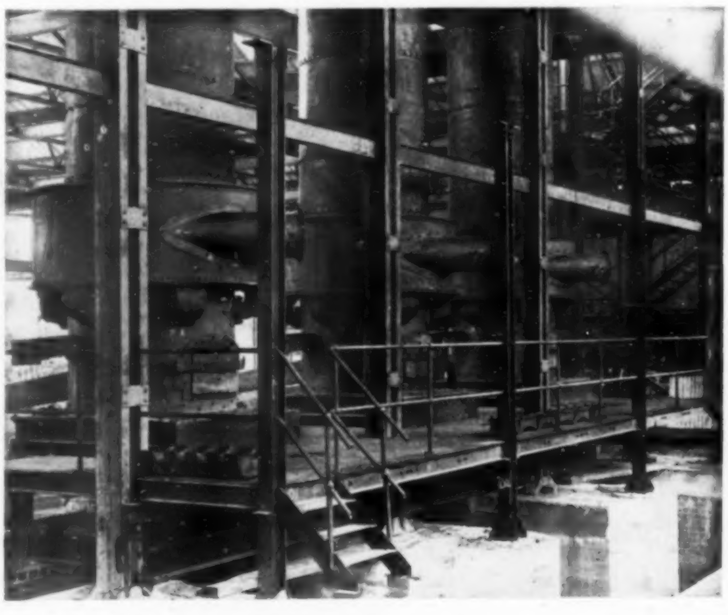

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to solidify is the δ solution, the form and distribution of which is easy to observe, as is illustrated in Fig. 2, which shows the δ distribution in a phosphor bronze. In bronze the lead is usually found associated with this delta material, and the form and distribution of the delta can be taken as an indication of the lead distribution. In chill-cast bronzes, or in sand-cast bronze where the solidification has been rapid, the lead will be scattered in tiny globules throughout the metal. On the other hand, in ordinary sand castings, where the solidification is not so rapid and the delta is allowed to form into fairly large masses, the lead will also occur in extensive colonies.

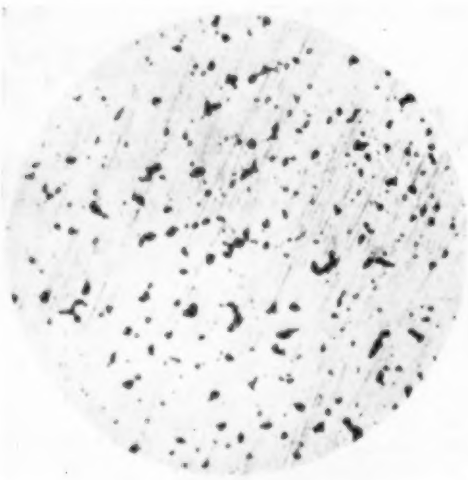


Fig. 1. Lead in Bronze. × 75.

Striking evidence of the behaviour of lead in bronze can be found from an examination of "tin sweat." This is the material which, in the form of white beads, is sometimes squeezed out of the tops of runners and risers during cooling. It makes its appearance particularly in phosphor bronze which has been cast too hot. The white "tin sweat" material is composed chiefly of the delta solution familiar in microsections, and when the bronze contains lead the exudation is invariably high in lead. Even from an alloy containing as little as ½% lead the segregate may contain 5 or 6% lead.

The insolubility of lead in brass and bronze makes it very liable to segregation and liquation, both in the liquid melt and during freezing of the alloy. On account of the high density of lead and its insolubility in the liquid alloys, it is liable to separate out and to settle to the bottom of a bath of liquid alloy. When castings are being made from metal melted in small crucibles, homogeneity can be secured by frequently stirring the metal during casting, but when large quantities of metal are melted it is difficult to prevent the lead settling to the bottom of the furnace. When this happens the last tapping will contain more lead than the first. There is little danger of serious liquation with low lead contents up to about 1%, but when the lead content is high the chance of liquation occurring should be guarded against.

Liquation is not confined to liquid alloys in the furnace or crucible. When the alloys are cast hot, so that freezing does not occur at once, liquation may take place in the mould. Brass is more liable than bronze to this type of trouble, especially if the lead content much exceeds 2%. In these cases castings may be found coated at the bottom with a layer of pure lead. With normal casting temperatures, when freezing commences immediately after pouring the liquid lead and alloy have no opportunity to separate into layers in the mould, but the lead will still be liable to the ordinary processes of segregation during the freezing of the alloy. It may be concentrated, for example, near the centre of large masses of the casting, in just the same way as sulphides concentrate near the centre of steel ingots.

Unless the lead content is very low, therefore, special precautions must be taken to secure homogeneity.

The tendency of lead to segregate is one of the main reasons for the low limits imposed on lead in specifications for brass and bronze for engineering parts. The effect of lead—when evenly distributed—on the mechanical properties is not so serious as to impose such strict limits on this impurity, but by confining the lead to low limits, the dangers from segregation are minimised. If it could be guaranteed that no segregation would occur a higher limit would in many cases be allowable.

The effect of lead on the mechanical properties of brass and bronze is fairly readily explainable by reference to its disposition in the microstructure, but that this has not always been fully realised even in recent times is evident from many statements which are found in technical literature.

There has been much dispute, in particular, about the effect of lead on the mechanical properties of bronzes. In the first volume of the *Journal of the Institute of Metals* this subject was raised, and the expressed opinion, which seems to have been in accord with general knowledge at that time, was that the strength of 90—10 bronze was reduced by the addition of lead, but in succeeding volumes of the *Journal* responsible researches first contradicted and then supported this several times in succession. In other technical literature, too, over a long period the same sort of contradictions can be found. The reason for many of these contradictions is undoubtedly that adequate attention was not given to the casting conditions in the preparation of the test bars upon which the results were based. In particular, the full effect of casting temperature has not always been fully realised. It is certain that small variations in the casting temperature may introduce variations in the strength of bronze far greater than the effect of small amounts of lead or other impurities. When the casting temperature is properly controlled and the effect of this variable is eliminated, the connection between the distribution of lead and the mechanical properties of bronze can be followed.

Fig. 2. Distribution of δ in Phosphor Bronze. × 50.

The strength of leaded bronze or brass may be regarded first of all as that of a mixture of weak lead and the normal strong alloy. On this basis the strength would be inversely proportional to the volume percentage of lead, but as the total weight of lead is usually low, and it has a high specific gravity, its volume percentage is very low. The manner in which it is distributed then assumes more importance than its actual amount. This is in accordance with general principles. It is found in many alloys that the effect of small amounts of insoluble impurities, such as sulphides, oxides, slag, and so on, is more dependent upon their

distribution than their actual amount. In brass or bronze one or two small globules of lead may have very little effect on the mechanical properties, but the same small amount of lead if dispersed throughout the structure in a very fine form will seriously lower the strength. The less the actual lead content, in fact, and the more important does its distribution become.

It is well known that slow solidification of alloys generally results in a coarse crystallisation, and rapid solidification produces fine crystals. When the solidification is rapid, therefore, the lead will be retained disseminated in very fine particles throughout the mass, but if the solidification is slow the lead will be permitted to segregate into pools. It would be expected immediately, therefore, that there would be a great difference between the effect of lead in chill-cast and in sand-cast materials. This is in fact the case, and approximate figures showing the effect of lead in sand and chill castings are given in Table I.

TABLE I.

	Sand Cast. Tons per Sq. In.	Chill Cast. Tons per Sq. In.
No lead	18	17
½% lead	18	15
2% lead	15	14

The ductility of cast brass and bronze is generally improved by the addition of small amounts of lead. All cast materials contain minute discontinuities, and in general their ductility is not so high as rolled or heat-treated alloys, in which the treatment closes up the fissures left by casting. Lead acts in the same way as rolling or heat-treatment, in that it fills up cavities left by the process of dendritic solidification by flowing into them during the cooling of the casting. The action of lead in filling up small discontinuities may be turned to good account in casting bronzes for hydraulic work. It is easier to obtain sound castings in a leaded bronze than in a lead-free alloy.

The hardness of all brasses and bronzes is reduced by the addition of lead. This result is to be expected from the presence of free soft lead in the alloy, and, similarly, to the effect of lead on the strength. The extent of the reduction in hardness by lead depends on the structure of the alloy and the distribution of the lead.

The main reason for allowing the addition of any lead to brass and bronze is that an improvement in the machinability of the alloys is gained thereby. This is the most clearly substantiated of the several valuable effects of lead. Lead-free alloys machine with surprising difficulty, considering their relative softness. A slight improvement in the machinability of pure bronze is gained by additions of phosphorus, but it is not possible to add phosphorus to zinc bronzes. The pure brasses also are more difficult to machine than the complex alloys, and some improvement may be gained by additions of tin and iron. There are, however, disadvantages to both these impurities. For example, the addition of tin increases the price of brass, and the addition of iron introduces a liability to rusting. The addition of a small amount of lead to any of these alloys brings about a surprising transformation far beyond that obtained by any other addition.

When machining lead-free alloys, the turnings come away in long awkward spirals, and if the cutting speed is higher than a very slow rate the metal quickly overheats. After the addition of a small amount of lead it is difficult to believe that it is the same basis alloy which is being machined. The turnings now chip off in small heavy curly pieces, and cutting speeds can be put up to the full capacity of the machine tool. The amount of lead necessary to bring about this change varies somewhat with the different alloys, but in all cases is quite small. Gunmetal requires only ½% lead to make it free cutting, and additions beyond ½% effect very little further improvement. With pure brass there is also a great improvement in the cutting with as little as ½% lead, but further improvement is gained by increasing the lead up to about 2%. Above 2% lead in brass improves the machinability scarcely at all.

MODERN FOUNDRY LAYOUT.

(*Continued from page* 80.)

installation. It consists of three Pneulec cupolas, each 3 ft. 6 in. diameter at the melting zone. These cupolas are supported on a steel structure upon large concrete columns, which form pits under each furnace. Each furnace is fitted with a drop bottom, which is operated by a toggle accessible from the tapping and fettling platform. The pits are arranged to receive bogies, which are placed under the furnaces, at the end of a blow, to receive the residue, when the bottom is dropped. Immediately the debris has entered the bogie a 5-ton crane lifts it clear of the foundry, and the contents are tipped and the unburnt coke reclaimed. Each of these cupolas carries a spark arrester, and to facilitate cleaning about them a special platform has been erected of similar size to the charging platform. The charging platform is 75 ft. × 40 ft., which gives ample space for an additional pair of cupolas, which have now been erected but are not yet in use. These latter cupolas are smaller, and were originally at the Oxford works of the company. The coke, limestone, pig iron, and scrap bunkers are suitably arranged on the charging platform, to ensure easy transfer to a tipping charging bucket, which is carried to any of the cupolas on a mono-rail. An auxiliary electric hoist conveys the shop scrap from the foundry level to the charging platform, which incidentally serves a useful purpose, in view of any breakdown of the conveying systems to the charging platform. Two Sirocco fans constitute the blowing equipment, and each is driven by a 45-h.p. motor supplying air at a pressure of 20 in. W.G. Each cupola is fitted with a blast gauge of Cambridge Instrument Co. construction. One fan delivers sufficient air for two cupolas.

The metal from the cupolas is tapped into 5 cwt. and 10 cwt. ladles, carried on mono-rails fitted with electric hoists. The procedure adopted in the operation of the cupolas is worthy of note. One cupola is blown in the morning and drawn before dinner. In the meantime, a second cupola has been prepared, and is ready for blowing after dinner, supplying metal for the remainder of the day. The third cupola is prepared for blowing the following morning, and it is possible with the aid of three cupolas to continue blowing two cupolas per day, drawing one in time to enable it to cool and be prepared for the following day. When the two smaller cupolas are put into commission the method may be modified somewhat according to requirements. It is interesting to note that a complete system of overhead runways operates throughout the foundry, and these, together with the conveyors, materially reduce the heavy manual labour frequently considered inseparable from foundry work.

At one side of the foundry a bay is allocated to general work. This is served with a battery of jar-ram machines for small work. The large work in this bay is organised on similar lines to those which operate in a normal good-class foundry. Electricity is taken from the Coventry Corporation mains at a pressure of 6,000 volts, and is transformed down to 400 volts, to be used for power, and 230 volts for lighting. Belliss compressors, which are direct driven by motors, supply the compressed air. Two supply air to the sand-blast plant at a pressure of 30 lb. per sq. in., while other two deliver air at 100 lb. pressure.

The Institute of Metals.

Preliminary Notice.

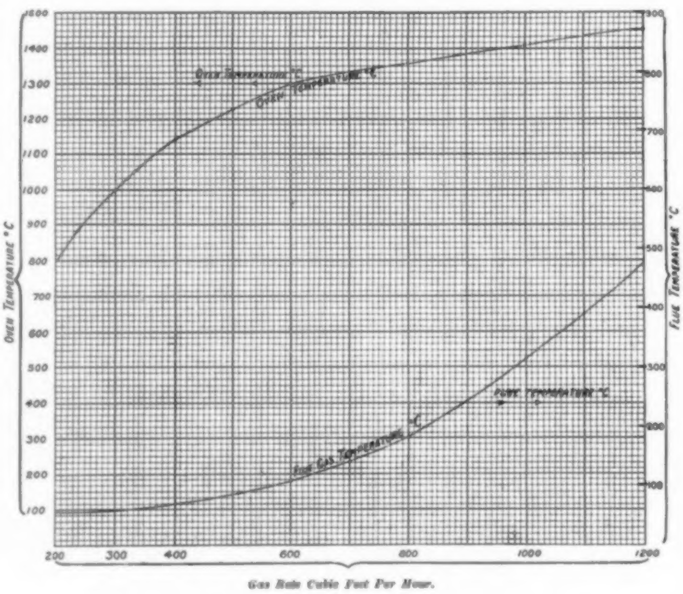
The annual autumn meetings of the Institute of Metals are to be held in the Chantry Hall, Southampton, from September 9 to 12 inclusive. The ninth autumn lecture will be delivered by Professor D. Hanson, D.Sc., on "The Use of Non-Ferrous Metals in the Aeronautical Industry." Arrangements are being made to visit France from September 13 to 16. Further particulars of this annual meeting will be published at a later date.

Economic Annealing Ovens

Gas Fired Furnaces designed on a recuperative system give High Efficiency.

THE satisfactory application of the principle of regeneration in gas-furnace firing has a considerable influence on the consumption of gas necessary for particular operations. In a non-regenerative furnace the products of combustion, which pass through the flue, contain a relatively high percentage of the total heat generated ; the percentage is variable, but rises with the increase in temperature of the furnace. The effective regeneration of the heat otherwise lost increases the efficiency of the furnace, and the importance of its recovery cannot be too strongly emphasised. By adopting a system of construction designed on scientific principles, not only are the heat units recovered available in the hearth, but they can be used for the actual work the furnace is performing. This is borne out by a series of 27 consecutive runs that have been made recently at Messrs. Qualcast, Ltd. The tests were made in their 6 ft. 0 in. × 5 ft. 0 in. × 5 ft. 0 in. "Revergen" furnace under normal working conditions.

During the period embraced by the test the total weight of castings annealed was approximately 60 tons. The gross load, which included castings, containers, and packing for the complete 27 rims weighed approximately 171½ tons, and the total gas consumption 382,860 cub. ft. Particulars of these runs are of interest since they indicate the average run and the daily procedure adopted.



	Tons.	Cwts.	Qrs.
Gross weight of materials charged per oven ..	6	7	0
This weight was made up as follows—			
Average weight of castings per oven........	2	0	0
Average weight of cast-iron containers	2	10	0
Average weight of packing (limestone and coke)	1	17	0
Average total weight	6	7	0

Daily Procedure.

Time taken for unloading, loading (fans), and bricking loose door .... 3 hours.

Time under fire—*i.e.*, when oven has been used the previous day .... 7 „

Temperature commences at 300° C.

1 hour	455° C.	4 hours	660° C.
2 hours	500° C.	5 „	740° C.
3 „	600° C.	6 „	790° C.
		7 „	810° C.

Time under fire, when oven is practically cold to commence .... 7 to 8½ hours

Temperature commences at 150° C.

1 hour	380° C.	5 hours	650° C.
2 hours	490° C.	6 „	700° C.
3 „	550° C.	7 „	750° C.
4 „	610° C.	8 „	800° C.

On reaching 800° C. to 820° C. the gas was turned off and the charge allowed to soak. The temperature dropped to 750° C. in half an hour, and 700° C. after soaking an hour.

The consumption of gas is readily calculated and gives the following results :—

	Cub. ft.
Gas per ton of gross load	2,232
Gas per lb. of gross load	0·99
Gas per ton of castings annealed	6,381
Gas per lb. of castings annealed	2·84

The furnace on which these tests have been made is gasfired on the Davis "Revergen" principle, by which a large part of the heat passing through the flue is regenerated and made available for work in the furnace. It demonstrates in a practical way the economic advantages of this system of firing, which maintains a given temperature within accurate limits at a very economical consumption of gas. The heat from the flue gases is used to supply hot air to the furnace which produces, within the hearth, conditions that promote an even distribution of heat throughout the chamber, and, by adequate regulation of the air supply, the atmospheric conditions in the furnace can be accurately controlled.

The regeneration principle brings within the scope of gas-fired furnaces, with their attendant advantages, higher temperatures and a wider range of commercial usefulness. Operations previously considered uneconomical in gas-fired furnaces are quite practical by means of this regenerative system of firing. With a Revergen furnace working at 1,000° C. the flue gases contain 45·5% of the heat generated by the combustion of the gas, but at the outlet of the regenerators the flue gases have a temperature of only 100° C., and will contain only about 5% of the heat generated.

The accompanying graph shows the oven temperature at progressive gas rates obtained from a recorded test of a Revergen oven furnace. Although the higher temperature exceeds that for which the recuperative system of the furnace under test was designed, it shows remarkably low flue-gas temperatures and demonstrates the economic advantages of an efficient system designed to make fuller use of the heat generated. In addition to a considerable reduction in fuel costs, this type of furnace is so designed that maintenance costs are remarkably low ; furnaces in which this system is adopted have been in continuous operation for many years, and the expenditure on renewals has been so small as to be almost negligible ; thus the overall costs of operation are comparatively low.

METALLURGIA

The British Journal of Metals.

Contributions suitable for the editorial pages are invited. Photographs and drawings suitable for reproduction are welcome. Contributions are paid for at the usual rates.

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Published Monthly by the Proprietors, THE KENNEDY PRESS LIMITED, at Kennedy House, Liverpool Road, Deansgate, Manchester.

Telegrams: "Kenpred," Manchester. *Telephone: Central 0098.*

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METALLURGIA

THE BRITISH JOURNAL OF METALS.

Co-operation in Foundry Development

By Fred P. Wilson, Esq., J.P.

President of the Institute of British Foundrymen.

Mr. Wilson was born at Middlesbrough. He served an engineering apprenticeship with Tees-side Engine Works, and Robt. Stephenson and Company, Ltd., Newcastle. He then entered the service of Wilsons, Pease and Co., Tees Iron Works, in 1892, and later became assistant blast-furnace manager, and had special experience in designing and working slag wool plant. Next he became foundry manager, the firm becoming Pease and Partners. Mr. Wilson is a Justice of the Peace for Middlesbrough, a member of the Education Committee, and of the Governing Council of the Constantine Technical College.

At the banquet held during the convention of the Institute of British Foundrymen at Middlesbrough I stated that the foundry industry had been in a rut. This was criticised and denied by a foundry employer, possibly because he misunderstood me. I do not, for a moment, maintain that the industry as a whole is still in a rut, and I believe our emergence from that unhealthy situation to be very largely due to the work of the Institute of British Foundrymen.

The policy of secrecy is not now so widespread. Founders are now recognising more completely that progress can only be effectually assured when there is mutual understanding and co-operation with a view to reducing difficulties with which the industry is beset. The policy, formerly so prevalent, in which each employer considered his own shop methods as perfect and not only excluded other foundrymen, lest ideas should be picked up and used in competition against him, but declined to mix with or compare notes with those engaged in similar work is rapidly dying. This attitude, which is never likely to be wholly eradicated, is nevertheless becoming less perceptible, and I say it is due to a considerable extent to the bringing together of foundrymen in the social environment of the convention and the Branch meeting.

I have heard it suggested by members that nearly as much good results from informal chats as from the formal reading of and discussions on papers, although in many branch meetings the discussions on papers are far from being formal. It is in the informal chats and discussions that reservations are forgotten and hearts are opened and friendships formed, which do much to convert a number of suspicious units into a brotherhood with a common aim and interest.

The Institute of British Foundrymen has shown that it is not going to be content with organising conventions and branches, and the Council has set before itself a heavy programme with a view to raising the status of the foundry still further. The technical activities of the Institute are being anticipated, and committees of the General Council are being rearranged to cope more effectively with the growing needs. The work of the Literary Awards and Education Committee has been growing rapidly, and a multiplicity of duties was formerly delegated to this committee and its various sub-committees. This committee will in future be known as the Literary and Awards Committee, and will be responsible for the selection and publication of papers and the distribution of awards. The Educational Sub-Committee will in future be known as the Education Committee, and will be responsible for the very important educational work which the Institute has undertaken. A new Technical Committee is taking over such work as was done by the Test Bar Committee, and will be responsible for initiating investigations, tests, researches, etc., into various technical problems. Sub-committees of specialists will be appointed from time to time to explore particular problems in foundry science and practice on lines similar to the investigations already so usefully carried out by the Test Bar Committee, and the results of the investigations will be reported to the main Technical Committee. It must be distinctly understood that this work is in no way competitive with that done so well by the British Cast-iron Research Association, but complementary to it. The Institute of British Foundrymen continues to recognise and appreciate the great value of the Association referred to.

The rearrangement of the work of the committees will undoubtedly enable the Institute to undertake valuable investigations into various technical matters associated with foundry practice, and there can be no question that such work will be of the utmost value to the members individually and to the industry as a whole.

The question of the education of entrants into the foundry industry is being dealt with very seriously, and the suggestions put forward by Dr. Ingall, Principal of the Constantine Technical College, Middlesbrough, at the convention, were eagerly listened to and discussed. Dr. Ingall first seeks the active co-operation of the employers and Technical Societies in Advisory Committees, and the help of local works as training grounds in craft work. He then proposes to add to existing evening classes a two-years full-time day course for the training of youths for managerial positions. Pure science is well catered for in the colleges of the country, but the curriculum now suggested for the day course is a new departure, and one which will have the very sympathetic interest of the Institute of British Foundrymen.

In co-operation with such bodies as the City and Guilds of London, the Institution of Mechanical Engineers, etc., the Institute is working steadily at the problem of craft certificates and also national certificates in foundry education, so that it is clear that it can hardly be accused of adopting a short-sighted policy.

I feel great confidence in saying that the industry is very much alive, and, generally speaking, if there are still foundries which remain antiquated in method and equipment, it is far more likely that it is due to the want of profits to produce the necessary capital than from lack of desire to modernise and develop. Those industries that are prosperous at the moment, such as the electrical and motor manufacturers, can show us examples of foundry plants that I believe will compare with any in the world.

In mechanical and manipulative skill our moulders are equal to any, but there is just the fear that the rising generation of youths may be lacking in education, both general and technical, unless the matter is tackled seriously. This is recognised definitely by the Institute of British Foundrymen, and the remarks above show that it is something more than a pious expression of opinion.

The Institute of British Foundrymen.

A Review of the Past Year's Activities.

By Wesley Lambert, Esq. A.K.C.

(*President*, 1929-1930).

THE recent Annual Meeting and Convention of the Institute, held at Middlesbrough, dates the commencement of the twenty-eighth year in the history of the Institute. The past year is acknowledged as being one of the most memorable years, if not the most memorable, since the formation in 1904 of the British Foundrymen's Association, as it was then called. The year was introduced by a pre-Convention tour through Great Britain, undertaken by many of the overseas visitors specially visiting this country to attend the Third Triennial International Foundry Congress held in London concurrently with the Institute's twenty-sixth Annual Meeting and Convention, commencing June 11, 1929. During the period covered by the Conference an International Foundry Exhibition, generally conceded to be the best of its kind organised in Great Britain, was held at the Royal Agricultural Hall, Islington, under the auspices of the Foundry Trades Equipment and Supplies Association. The exhibition not only included foundry equipment, but, thanks to an influential Technical Committee, with which Dr. Rosenhain, F.R.S., of the National Physical Laboratory, heartily co-operated, an excellently arranged and comprehensive technical exhibit was staged. This exhibit, covering as it did a variety of technical subjects connected with the foundry industry, was highly commended, and proved that Germany is not alone in being able to organise a valuable educational foundry technical exhibition.

Should one have occasion to review the outstanding reasons which have led up to the latter day progress in foundry technique, not least important will be the facilities for works visits which have been so generously accorded by a large number of proprietors of engineering works and foundries, not only in this country, but also abroad, and of which many members of the Institute have taken full advantage.

The civic welcome by the Lord Mayor of London at the opening of the London Congress in the historical City Council Chamber of the Guildhall will long be remembered and talked about, and was a fitting complement to the welcome of the municipal officers and authorities of other cities and towns visited during the pre-Convention tour. The use of the City Council Chamber for the opening meetings of the Conference, and the exclusive use of the Guildhall for an afternoon reception were generous concessions which, together with the reception by the Lord Mayor, in his ceremonial robes and attended by his officers, will always be considered by those attending the Congress as marking a red-letter day in their lives not likely to be forgotten for many years to come; such concessions reflecting the appreciation of the City of London of the importance of the foundry industry in the business of the nation. The support of the President at the Congress Banquet at the Hotel Cecil by so many notable personalities in science, trade, commerce, and industry, is a pleasing reminiscence, and served to emphasise further the status which is now accorded to the foundry industry. No longer can one refer disparagingly to the foundry as the Cinderella of the engineering trades.

The higher status which the foundry has to-day acquired has caused an almost unprecedented wave of enthusiasm in the ranks of the Institute towards the efforts now being made for the promotion of facilities for the betterment of the education of the young foundry worker with a view to safeguarding the maintenance of this high status by ensuring a sufficient complement of trained graduates to follow in succession to the skilled craftsmen to whom the higher status of the Institute is largely due. The Technical Institutes and Colleges throughout the country are heartily co-operating in this educational scheme, and an influential Advisory Committee is in operation to assist in the formulating of suitable courses of study and in the drafting of syllabuses to meet the examinations for both the proposed craft certificate and the higher technical diploma, which awards, it is hoped, will be of a national character. The Institute of Mechanical Engineers and the City and Guilds of London Institute, to mention only two examining bodies, are actively working in conjunction with the Institute of British Foundrymen in its laudable aims to secure for earnest workers and students in the foundries of the Empire the better status which such certificates and diplomas will confer.

For some time past, and more particularly within the last twelve months, it has been borne upon the members of the I.B.F. that the activities of the Institute, in a technical direction, have not heretofore been sufficiently commensurate with the standing of the Institute, representing as it does one of the most important branches of the industry of the country. Reference to the Year Book of the American Foundrymen's Association, and to the published address delivered recently in London by Dr. Werner, one of the highest authorities connected with the foundry industry in Germany, indicate very clearly that the Foundry Associations in at least those two countries have an activity and a sphere of interest much broader than the Institute of British Foundrymen has as yet attempted. The establishment of a parent Technical Committee, with the object of forming a number of Technical Sub-Committees, will be, it is felt, of incalculable value to the members of the Institute as a whole, and will tend to stimulate the larger interest of the individual member by affording the means whereby a larger number of members will be enabled personally to participate in the activities of the Institute and to serve on such Sub-Committees. It is fully recognised that the Institute has not taken full advantage in the past of the highly specialised talent available among the roll of its members. Work which is now being done by the British Cast-Iron Research Association could undoubtedly more fittingly be done through technical sub-committees associated with the Institute, thus leaving the B.C.I.R.A. to devote more of its time and interest to organised research work, such, for instance, as that which has culminated recently in the introduction to the foundry industry of a new heat-resisting cast iron which promises to have a very wide application in engineering products. Technical sub-committees on cupola-working, malleable-iron castings, foundry transportation, sand treatment and reclamation, fuel, liquid contraction of metals, refractories, core-binders, top and bottom pouring-ladles, and on many other technical subjects are likely to be formed and in operation within a very short time. The conclusions and recommendations of the various committees will be circulated to members of the Institute, probably by means of a periodical bulletin.

A further important enterprise of the Institute recently put into action is that of establishing foreign corresponding members. Much can be gleaned from overseas foundry practice, and in this connection several names of distinguished foreign members have recently been submitted to the Council of the Institute for confirmation as representative foreign correspondents.

One of the most encouraging signs of the life and interest of the Institute is the number and value of the technical and scientific papers presented at the Annual Conference and at the Branch meetings, and also as exchange papers between different associations. Nearly one hundred papers have been submitted during the past year, four of which were recommended to and confirmed by the Council as meriting the diploma of the Institute; the respective authors of which papers were duly publicly notified of this award at the Middlesbrough Conference.

The junior branches of the Institute, although to-day not numerically as strong as the parent Institute would wish, will, it is anticipated, receive a strong incentive to increase their membership rolls following the results of the efforts, already mentioned, now being made by the Institute through its Education Committee to establish certificates and diplomas of a national character for the aspiring members of the foundry craft.

Correspondence.

To the Editor, Metallurgia.

Dear Sir,—I am considering the manufacture of malleable iron or steel pressed and welded pipe fittings, and I would be glad if you could obtain quotations for suitable plants, supplying full details and quoting each unit or part unit separately.

The fittings I propose making are from ¼ in. to 2 in. inclusive, and are of a pattern similar to the G.F. fitting made in Sweden. I am not quite sure which would be more economical to produce, and would be glad to have prices of plant to produce malleable-iron castings and also plant for steel pressed and welded pipe fittings, calculating on a production basis of 20 tons per month. In the first place I would like quotations for moulding machines operated by hand or compressed air, with the output per day or week, so that I could prepare cost for sand conditioning, and conveyer or elevator plant, compresser, and plant for sand blasting. I would need prices for core-making machines, pattern plates, and core boxes for all patterns of fittings within the sizes mentioned. I would need three screwing machines, one four-way machine to screw fittings from ¼ in. to 2 in. inclusive, one four-way machine to screw fittings from ¼ in. to 1 in. inclusive, and one machine to tap and screw reducing bushes, sockets, and nipples. These machines would need to be complete with formers to hold fittings, lead screws, and inside and outside screw attachments, and the tap would need to be held firmly in socket of machine so that it could not get out of line in the screwing. All the fittings to be made would be Whitworth gas standard. I also need a galvanising plant, either electric galvanising or pickling and hot immersion—which of the two I would prefer depends upon which is best, cheapest, and most reliable on malleable iron.

The method adopted here for melting the metal is usually ordinary coke-charged cupolas. I would welcome any suggestions on more modern methods, and would be glad to have particulars particularly of electric melting.

It is advisable to detail the parts minutely, as the duty on some articles is different from others, and I would have to go through the list, if business resulted, to arrange the articles in different parcels. Where electric motors are involved kindly quote the machine complete.—Yours, etc.,

R. A. M.

Alberton, South Australia.

[Communications respecting our correspondent's request will be dealt with in strict confidence.—Ed.]

To the Editor, Metallurgia.

Nickel in Malleable Cast Iron.

Dear Sir,—I have read with great interest the article on "The Effects of Nickel upon Malleable Cast Iron" published on page 67 of your June issue, and which reports some of the results obtained by J. V. Murray in his research on this subject. As I have been closely associated with research work and industrial developments with nickel in various types of cast iron, I would like to submit one or two comments on various points which are mentioned.

In the first place, I notice that Mr. Murray encountered difficulty in adding the nickel by placing "F" shot in the bottom of a ladle and tapping the iron on to it. It seems to be a matter of general experience that such a method of adding any material to the ladle of molten iron proves unsatisfactory. Extensive experience has shown, however, that the alternative methods of making the addition to the metal stream in the spout of the cupola, or of adding the alloys to the ladle while the latter is actually being filled, prove successful and give consistent results.

By these methods, as Mr. Murray confirms, there is no loss of nickel, since this metal is not readily oxidised, and, moreover, once alloying is complete there is little or no tendency for segregation of this metal.

Referring to the results obtained by Mr. Murray, some of these would require confirmation, as, for example, the physical test figures shown for the fourth and fifth samples in Table 2. The wide variation shown for the elongation of these specimens would appear to suggest something in the way of experimental error, and the results in these cases demand further investigation.

On the whole, however, the results confirm experiments which have been carried out elsewhere. Beneficial influence on some of the properties of the malleablised castings is shown for about 1% of nickel; although it should be stressed that there are so many variables involved that results depend very much on the conditions under which the tests are carried out.

A feature brought out by Mr. Murray's results, which is worthy of some emphasis, is that nickel is definitely a graphitising agent, and its addition to an ordinary white-iron mixture as used for raw malleable castings may result in the formation of primary graphite, which will spoil the castings for malleabilising. In any experiments in this direction, accordingly, the first step must clearly be to determine the maximum percentage of nickel which may be added without the appearance of any mottle in the fracture of the raw casting. In all further experiments with this same base iron this predetermined amount of nickel must not be exceeded.

I note that in his metallographical investigations Mr. Murray does not mention the influence of nickel on graphite size. It is of interest in this connection to note that in much of the work which has been done elsewhere it is observed that in the malleabilised castings the graphite form is definitely finer in the presence of 1% of nickel, and this should be added to the features which increase the physical properties of the metal.

One feature, however, which appears to have been overlooked in this article is the influence of nickel on the annealing conditions of the iron. It is well known that nickel affects the temperatures of the critical points, and also affects the time required for annealing the castings. The conditions which give the best results with an ordinary malleable iron mixture are most likely not the best for a composition of iron containing 1% or more of nickel.

The problem of the influence of nickel on malleable cast iron is exceedingly complex on account of the large number of variables which have to be considered. The present work, however, indicates once again that, under suitable conditions, nickel may have beneficial effects on the castings. A very great deal of ground, however, has yet to be covered before the full influence of nickel is established and its potentialities accordingly can be realised. Not only is it possible that the influence of nickel on annealing conditions might lead to modification of this part of the operation which would result in overall economy, but the effects of nickel are more extensive than can be measured by the ordinary standard physical tests, and where special problems arise nickel will no doubt in the future prove a helpful tool in conferring special properties on malleable cast iron. —Yours, etc.,

Arthur B. Everest.

July 4, 1930.

To the Editor, Metallurgia.

Dear Sir,—I was very interested in the article on "Pulverised Fuel and Its Applications" in your June issue. It has, no doubt, a great future. The main drawback is the rapid wear of the attritor in most designs, and in one that I know of in particular. It is choking in the delivery due to the moisture and high percentage of volatile matter in the English coals. With these difficulties in view, I have recently designed a three-stage pulveriser which relieves the attritor disc of a great part of the work. It also has free delivery, together with other desirable features. Whether the design would prove an advance on those at present in use I cannot say, but I would be glad to be placed in touch with those who are interested.—Yours truly,

D. R. N.

[We would be pleased to forward any communications on this matter to our correspondent.—Ed.]

The Foundrymen's Convention at Middlesbrough.

THE Institute of British Foundrymen held its Twenty-seventh Annual Convention at Middlesbrough from Tuesday, June 17, to Friday, June 20, under the Presidency of Mr. F. P. Wilson, J.P. This is the second occasion that the Institute has held its annual meetings at Middlesbrough, the other occasion being in 1906. Although the local branch of the Institute has only been established four years it is a particularly active one, and they are to be congratulated for the energy and forethought displayed in arranging an admirable programme.

A reception was held on Tuesday evening in the Constantine Technical College, at which the visitors were received by Mr. and Mrs. William Shaw. Under the direction of Dr. Ingall, the Principal of the College, the numerous laboratories and workshops were opened for inspection, and parties were conducted over by students. It is of interest to note that this college has been arranged to meet the needs of the predominating industries in the district; special equipment having been installed for metallurgy, engineering, and chemistry. Included in the metallurgical section is an experimental foundry, and it is proposed to inaugurate a day course in foundry work. This college, which has been provided through the generosity of the late Mr. Joseph Constantine and family, was officially opened on July 2 by the Prince of Wales. The business of the convention was opened on Wednesday morning by the retiring President, Mr. Wesley Lambert. He introduced His Worship the Mayor of Middlesbrough (Alderman T. J. Kedward), who extended a hearty welcome to members of the Institute and visitors on behalf of the citizens of Middlesbrough, and, after delivering a very interesting historical account of the district, was invited to present the Oliver Stubbs' Gold Medal. On this occasion the recipient was Mr. James Ellis for sterling work on behalf of the Institute, and more particularly for his efforts to encourage the Junior Section. Mr. Ellis was one of the first presidents of the Institute, and is probably its oldest member.

At the conclusion of the civic welcome the annual general meeting of the Institute was continued, and the General Council submitted their report, which was unanimously adopted. Subsequently, Mr. Lambert vacated the chair in favour of the newly elected President, Mr. Wilson, and the other officers for the ensuing year were then elected. Messrs. A. Harley and V. Stobie were elected senior and junior Vice-Presidents respectively, while in view of the retirement of Mr. F. W. Finch from the position of Treasurer, Mr. W. B. Lake was elected to this honorary position.

The General Secretary, Mr. T. Makemson, announced the Council's decisions in regard to the awards. Diplomas were awarded to Messrs. C. H. Kain, D. K. Barclay, S. Southcott, and T. Service for papers read at various branch meetings during the past session. Buchanan medals were awarded to Mr. E. Sutcliffe and Mr. Hubball. Mr. Wilson, in his presidential address, referred to complaints that some of the older and larger societies are leading their ordinary members quite out of their depth. This is not the case with this Institute. It might, he said, be classed as a vertical section of the foundry industry, and the last thing to be developed is a series of horizontal sections. Continuing, he made special reference to the educational facilities afforded at Constantine College, and what virtually amounts to pioneer work that is to be attempted. A natural outcome of special training is the institution of a national certificate, which will be recognised by employers as some definite standard of attainment. He carried the subject further when considering the status of the Institute. It is well known that some technical societies found in course of time that it would be to the material advantage of their members if they could show by the fact of their membership that they had certain qualifications. This led to the institution of examinations as a qualification for membership. While he appreciated the difficulties the time may have arrived when the status of the Institute might be enhanced by some qualification for membership.

The President commented upon the cordial relations existing between the Institute and the kindred societies in America and on the Continent. The interchange of papers and visits from time to time are factors of no small value in cementing the nations together in the bonds of mutual friendship and respect.

Following the President's address, the presentation of papers was commenced, and sessions were held in the main hall and in a lecture theatre. The sessions were held during the mornings of Wednesday and Thursday, and ten papers were presented. They were remarkable in the fact that they were all practical, and only one dealt with non-ferrous work; they were nevertheless diverse in character. In any case it would be impossible, or at least extremely difficult, to encompass all the interests represented by the Institute in the brief time available at such a convention. On the whole the sessions were well attended and useful discussion resulted. It is only possible here to review the papers somewhat briefly.

Briquetting Cast-iron Borings for Cupola Melting.

The question is frequently asked how can we reduce the cost of our product and at the same time maintain the standard of quality? The answer, generally, is – by the use use of more efficient methods and equipment; by better control through closer supervision; and perhaps through the reduction of scrap and waste. Nearly everyone will agree that it is usually necessary to spend money in order to save money, especially in industry to-day. It is with this thought in mind that Mr. F. J. Walls in his paper, which is presented on behalf of the American Foundrymen's Association, considering first the cost of the installation, endeavours to point out the savings involved, the principles of the operation of the machine, and the effects of the briquette on the metal.

The machine and equipment as installed at the Wilson Foundry and Machine Co., Pontiac, Michigan, is considered. The total cost of installation amounted to £13,545, and the machine produces briquettes at the rate of 18 per minute. They are 4 in. in diameter and about 3 in. long, and each weigh, on an average, 7 lb.; thus the production rate of the machine is 3·37 tons per hour.

In actual practice the cost of producing the briquettes, which included labour, maintenance, and depreciation, averaged 8s. 6½d. per ton. It is claimed that the market price of cast-iron borings varies from £2 to £2 16s. under the price of pig-iron in the Michigan district, and a considerable saving can be affected. In the case referred to a saving of 9s. 8d. per ton of iron charged into the cupola was effected. Over a recorded period 24,936 tons were melted, which gave a saving of £12,259. It is interesting to note that while there was a loss of 26% in silicon and 21% in manganese, the physical properties of the metal as well as the structure were good. The average tensile strength

of metal obtained during a month's trial with and without briquettes gave 14·90 and 15·11 tons per square inch, respectively.

It is undoubtedly true, as the author suggests, that the question whether or not these briquettes can be used successfully in the cupola resolves itself into a problem of economics, as the use of 20% of these briquettes has, apparently, no detrimental effect on the quality of metal produced. The cost of the installation is very considerable, and there are few firms in this country capable of using the briquettes to such an extent as to render it an economical proposition. Marketing the briquettes offers possibilities with such a plant, but the difference between the market prices of cast-iron borings and pig-iron is not so great as in the Michigan district.

The Economic Utilisation of British Pig-iron Resources.

This paper correlates the latest information regarding the constituents and characteristics of different brands of British pig irons. The table which forms the fundamental basis of this paper will enable a foundryman to select varied brands for his own particular purpose, using pig irons as near his locality as possible. The information has been sought from makers throughout the country, and the assembled details form a very comprehensive work of reference. The authors, Messrs. C. H. and N. D. Risdale, confined themselves to the metallurgical side of the question, and refrained from a consideration of the economic utilisation as far as it concerned prices. The authors discussed the inherent qualities of pig irons—a very delicate and controversial subject—and indicated difficulties in obtaining information on what fundamental difference in characteristics and properties really existed between cold- and hot-blast iron. A founder must never forget that the first economic consideration is to produce good, commercially sound, and saleable castings, and unless he is able to do this from superior knowledge and experience, and has facilities for carrying out operations under close scientific control, it may be more economical for him to buy ready-made iron, which will simply need remelting to yield castings of the composition, and giving the properties he requires, than to try and make up equivalent mixtures from cheaper irons.

In referring to the subject under discussion, Mr. J. E. Fletcher said that in the Cleveland district one of the most remarkable series of pig irons the world had ever known had been manufactured for many years, and for many years its reliability had been unequalled. The recent tendency to displace natural pig irons by mixtures of pig iron and steel presented a problem which was occupying the minds of foundrymen, especially those who were called upon to make high-duty irons. It was worth while considering very closely whether they should encourage the blast-furnacemen to make irons having analyses very close to those of the castings desired, or whether the iron-producers' trade should be spoiled by using something else which was not all users would like it to be.

The Founding of Bronze Gear Blanks.

Modern methods and materials are such that high efficiencies can be obtained with the added advantages of quietness in operation. This assertion is made in a paper on the above subject presented by Mr. F. W. Rowe. Some excellent illustrations were thrown on a lantern screen to show the macro- and micro-structures obtained when phosphor-bronze castings were made in the three principal ways now in use, viz., sand cast, chill cast, and by the new centrifugal process using sea-sand core. In the latter case the usual dentritic structure had almost completely disappeared, whilst the suppression of the greater portion of the alpha-delta eutectoid which occurs in chill castings was almost completely absent.

The discussion was opened by Mr. H. C. Dews by referring to the statement made in connection with the coke used for melting the bronze, and the sulphur which entered the metal when the coke was too high in sulphur content. He had been melting phosphor bronze in a similar type of reverberatory furnace, and although he recognised that the quality of the coke was of fundamental importance, he had not understood that the sulphur gave increased shrinkage when it got into the bronze, as he had never succeeded in getting it to enter. In his further remarks he asked for details of the sea-sand core used in centrifugal moulds for wheel blanks, and wondered why an oil-sand core could not be used to resist the searching action of the molten phosphor bronze, which entered any cracks and made fins.

Mr. J. S. G. Primrose commented upon the structure of the centrifugal-cast metal in which the chief difference from ordinary sand-cast metal was the elimination of the dendritic structure. It was also remarkable that, whilst chill casting prevented the separation of the alpha-delta eutectoid, the centrifugal casting seemed to produce no diminution in the amount of eutectoid. On the question of sulphur absorption producing excessive shrinkage, he raised the question as to the amount needed to do this, and preferred to use oil-furnace melting to obviate this occurrence. Mr. W. A. Logan agreed with the author in need of a covering, and had found charcoal to be the most useful. He asked why in chill castings the delta eutectoid was almost entirely absent, whilst in centrifugal castings, under similar cooling conditions, the delta was present in almost the same amount as in sand castings.

Mr. A. Harley, who presided, said that he had seen sand castings used for gearwheels in high-class cars for a number of years and they had given good service. So also had many chilled castings for the same purpose, and he wondered if there was any great superiority over these in the use of centrifugal castings. He considered that the method of casting was only part of the story, as the design of the teeth, the machining, and strength in relation to working load were all important factors.

In replying to the discussion, Mr. F. W. Rowe first dealt with the question of sulphur in the coke, which must also have the best physical properties in order to get good working in the large reverberatory furnaces he had referred to. He assured Mr. Dews that he had experienced trouble with excessive shrinkage under the risers, and had definitely traced it to sulphur in the bronze, which became excessive when the coke contained from 1·3 to 1·8% of sulphur. The actual sulphur in the bronze was normally as low as 0·003 to 0·005%, but difficulty was experienced when it was found to be as high as 0·05 to 0·05%. He had intended to refer to phosphor bronze throughout. The sea-sand core was the only one possible for the centrifugal process, and it required to be properly bonded and given a double coating of refractory wash. Care was needed in getting the right mixture, which differed for various sizes, as it had to stand up to the heavy wash of molten metal and be sufficiently strong to be spun.

The mechanical tests on centrifugally cast metals had all been taken from actual gear blanks, and showed that they were superior to ordinary-cast metal. The improvement in the removal of the dendrites was chiefly in the direction of getting a higher shock strength in the gearwheels, and this would be included in an appendix. He had not traced the existence of beta in the chilled structure except in a very few cases, but there was no doubt that it was the rate of cooling which influenced the amount of free delta eutectoid separated. In the chilled casting the rate was rapid at first and then slowed down, and this differential cooling favoured the suppression of the delta change, whereas in centrifugal castings the rate was uniform, and this favoured the alpha-delta separation.

He admitted that it was possible to get either sand or chilled cast gearwheels to give excellent results in service provided the working load was light enough, but heavy loads and shocks which would produce failure would be successfully met by a centrifugal casting.

Methods of Moulding Castings for Stoves and Heating Apparatus.

This paper, by Monsieur H. Magdelevat, on behalf of the French Foundrymen's Association, was presented as the French exchange paper. It deals more particularly with the production of light castings on a repetition basis by means of the Rosieres-Bachon system. This comprises a continuous-moulding machine layout. To carry out any industrial operation, says the author, the primary movements should give continuity of manufacture and continuity of action. It is this principle of continuity in its dual aspect that underlies the conception and development of the Rosieres-Bachon patent continuous moulding machine, which in itself really constitutes a complete continuous moulding shop. The paper includes a full description of the operations of this system, and concludes with a reference to the advantages derived from its use.

The Preparation of Metal for Steel Castings in the Converter.

This paper is the result of tests made by the author, Monsieur J. Leonard, who is President of the Association Technique de Fouderie of Belgium, together with data derived from "The Steel Foundry" by John Howe Hall. They have been applied only to converters of small capacity, side-blown and worked by the acid process. He considers the principle of operation and determines the calories resulting from reactions when the various substances are oxidised. In his personal tests, he has found that by attending to various points it was possible to carry out large numbers of operations under extremely regular conditions as regards time (converter with a capacity of 1,500 kilogs., initial period 4 mins., total duration 15 to 16 mins.), and to produce a sound metal, whilst entirely eliminating wild casting.

This system of production places the author in disagreement with Howe when he mentions 14 to 30 mins. as the entire duration of a heat, and with most of the operators whom he has consulted with regard to the necessity of various additions and various movements up and down of the vessel. It is considered that with a good start as regards quality of metal and temperature, and with the air and metal levels well regulated, the operator can, and ought to, produce an excellent casting by merely actuating the blast-regulator valve.

The Future of the Side-blown Converter in the Steel Foundry.

In presenting this paper, Mr. J. Deschamps pointed out that for a given temperature side-blown converter steel has a greater fluidity than steel made by any other method and appreciable economies resulted, in refractories and in the amount of steel required for feeder heads, from its use. The high fluidity facilitates deoxidation of the steel and enables the slag to rise readily. Although the process results in the steel containing originally a greater proportion of oxides, occluded gases, and silicate inclusions than open-hearth or electric steels, its greater fluidity renders easier the elimination of these impurities. The converter gives greater flexibility than the open-hearth and electric process. In a well-organised plant consisting, for instance, of two cupolas, each of 6 tons capacity per hour, and each capable of feeding three converters of 30 cwts. each, it is possible to supply regularly 1¼ tons of steel every 15 minutes.

Recent developments in the cupola-converter process of steel making have shown that it is possible to produce in side-blown converters of, say, 30-cwt. capacity—from a cupola charge consisting of 70% low phosphorus-steel scrap, and 30% high-silicon, low-phosphorus, hematite pig iron, melted with 10% coke, the heat being blown in the converter in about 20 minutes—a steel of, say, 0·15% C, 0·3% Si, 0·6% Mn, 0·03% S, and 0·04% P, which, after standard annealing, will give 30 tons per square inch tensile, 55% reduction in area, 38% elongation, and a cold-bend test of 180° without fracture.

The most important factors determining the installation of a converter plant referred to in the paper are availability of cheap and plentiful steel scrap reasonably low in phosphorus, and class of castings to be produced. In a general steel foundry, which has to make at the same time small intricate castings on a semi-repetition basis, and plain, heavy castings, the ideal plant would consist of a basic-lined open-hearth furnace and a battery of semi-blown converters.

The Economic Utilisation of Compressed Air in Steel Foundry Practice.

Introducing his paper, Mr. T. W. Barley emphasised many outstanding points in the compression and use of compressed air to ensure economy. Wherever possible he recommended the use of a central station and high-class compressors built to guaranteed output of compressed air for a given input of power under test. The use of volume and pressure recorders for the air and power recorders for the prime movers was invaluable, and daily readings should be tabulated for ready and rapid comparison. The compressor attendants should understand that they have a worth-while job, and that the management consider it as such. The tools should be kept efficient by proper maintenance and testing at regular intervals. Periodical tests should be made for leaks, and when shown on instruments should be found and rectified. Waste of air by misuse should not be permitted.

He further emphasised the use of high-grade oil for the compressors, as not only will better results be obtained, but the cost over a period will be no greater than by using a cheap oil. The compressor valves and the moving parts of the air tools need close attention. The discussion was opened by Mr. Shaw, who questioned the advisability of central units and suggested that separate units gave greater flexibility. Mr. Deschamps stated he had experienced difficulties as a result of water forming. Several members suggested that the more economic compression resulting from the use of a central unit was more than counterbalanced by the loss of power in using it over longer distances. A member wished to know if there were any air-tight valves. Mr. Barley advocated the installation of high-pressure units to be reduced for certain kinds of work. He had proved central units to be more economical. In regard to air-tight valves, he appreciated the difficulty, and stated he had found the use of grease very useful in preventing leakages from valves.

The Production of Large and Medium-sized High-class Iron Castings.

This interesting and very practical paper, presented by Mr. W. Scott, illustrated the art of moulding rather than the employment of mechanical devices. It stressed in no uncertain manner that skill and ability are still essential in producing sound castings of large and complicated work. The author considered more particularly the production of castings for Diesel engines and turbines, and illustrated the methods adopted by Sir W. G. Armstrong Whitworth and Co. (Ironfounders), Ltd. Paying a tribute to the skilled craftsmen employed on this class of work, Mr. Scott made special mention of the loam moulders upon whom the successful manufacture of high-class castings, apart from the repetition class, chiefly depends. However good the foundry supervision and the supply of the right materials at the proper time, much depends on the craftsmen. There is a fund of detailed information in this paper which will prove valuable to those engaged in the production of large castings.

The Reclamation of Oil-sand Cores.

The economic possibilities of reclaiming oil-sand cores were referred to by Mr. Frank Hudson when he introduced his paper, in which he endeavoured to establish a case.

One of the points mitigating against the universal adoption of oil-sand cores at the present time is the cost increase over ordinary moulding-sand mixtures. Most foundries, however, appreciate that the benefits accruing from the use of oil-sand cores more than compensate for their increased cost. At the same time keen competitive markets enforce economic working. In oil-sand practice a common complaint arises in the monetary loss caused through the disposal and inability to re-use old core sand, and a few foundries have become fully alive to the value of reclaiming this material. The reclamation of oil-sand cores is practised in a few instances, but the successful universal practical application of the problem has still to come. Even in the United States of America, where extensive sand reclamation is the general rule, the re-use of oil sand in cores has not yet been successfully adopted, though large quantities are reclaimed to make moulding sand.

The Factor of Personnel with Regard to the Future of British Foundry Practice.

The difficulties associated with the training of foundrymen in the technique of their work have long been recognised, and they are fully appreciated by Dr. Ingall, who in a paper described a scheme which is being put into operation at the Constantine College, of which he is Principal. The scheme obviously is experimental, but a number of very influential firms in the district are supporting it and have appointed representatives on a Foundry Advisory Committee. Dr. Ingall described how the scheme has been put into operation with about 70 students selected by various firms. A Special Advisory Committee has also been formed consisting of representatives of the Institute of British Foundrymen, the Iron and Steel Institute, the Institute of Metals, the British Cast-iron Research Association, and also the Foundry Advisory Committee previously referred to. The scheme as outlined by the author was well received, and although many points arose as a result of a full discussion all the speakers voiced their appreciation of the manner in which Dr. Ingall had tackled a very difficult task. During the course of the discussion, Mr. J. H. Smeaton made a very magnanimous offer to bear the expense of sending six students each year for five years to spend their three months' vacations in German foundries.

The results of this education effort to develop the training of foundrymen, and, incidentally, to improve the status of the foundry industry, will be watched with keen interest by all who have the interests of the industry at heart, and its success will have a considerable influence on the provision of similar educational facilities in other industrial centres not now adequately served.

Foundrymen Visit Works in Middlesbrough District

ONE of the advantages of holding a conference in an industrial centre is the facilities usually given to visit works in the locality. This not only gives members opportunities for widening their outlook and obtaining information respecting various processes, but also enables members to reciprocate with ideas and suggestions that may be helpful to executives of the works that are being visited. At this Conference the arrangements for visiting the works in the locality were excellent.

On Wednesday a party of about seventy strong was entertained to luncheon by Messrs. Dorman Long and Co., Ltd., as a preliminary to a visit to their Cleveland works on the south bank of the Tees. These works were founded by Mr. W. F. Bolckow and Mr. John Vaughan, whose partnership began in 1839. In 1850 Mr. Vaughan discovered the main seam of Cleveland stone, and built the first blast furnace on the Tees. This company were also pioneers in England of the Bessemer process of steel-making, and later of the basic process. The Cleveland works are the latest acquisition of Dorman Long and Co., Ltd., as a result of the merger of the two companies in 1929. They are situated only a few miles from Eston Hills, where the best Cleveland iron stone is obtained and conveyed into the works by private railway.

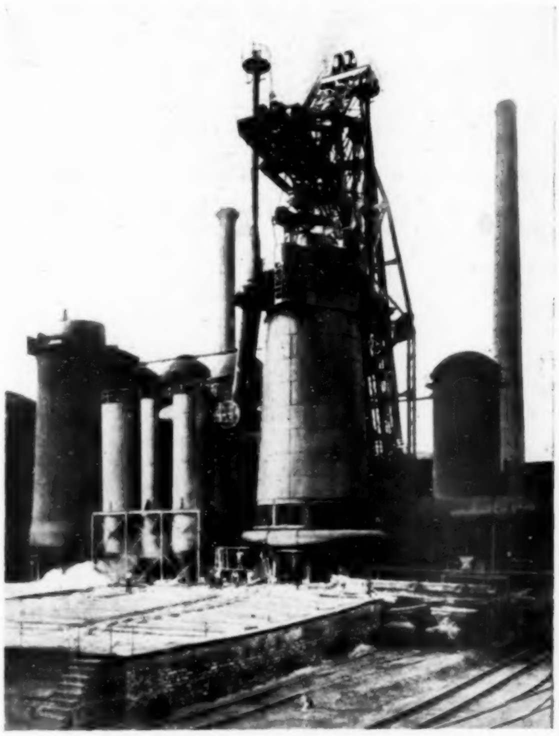
The works now consist of four blast-furnace plants, with a capacity of over 10,000 tons per week. The furnaces are mechanically charged. There are two melting shops and three mills, a 34 in. two-high rail and section mill, consisting of cogging mill and roughing and finishing stands, with ample hot and cold bank and finishing accommodation ; an 18 in. three-high mill for rolling light sections and billets ; and a three-high reversing plate mill specially designed for the manufacture of ships' plates. The works also include well-equipped fitting and engineering shops, a plant for the production of hydrogen and oxygen by the electrolitic process, and, in addition, these works manufacture bricks, road material, concrete slabs, and kerb stones from blast-furnace slag. The party were more than delighted by the cordiality of their reception by the works executives.

On the same day a large number of visitors made an inspection of the shipyard and docks of Messrs. Smith Dock and Co., Ltd., at South Bank. This company is one of the largest dry-dock owners and ship repairers in the world. The shipyard and docks were laid out twenty-one years ago, and during this period 490 vessels have been launched, 400 marine engines have been built, and thousands of vessels have been docked for repairs. There are six shipbuilding berths at each of which a 400-ft. vessel can be built, or, instead, three trawlers can be built on each berth. There are four large dry docks, which take vessels up to 575 ft., and the engine-shops, which proved to be of considerable interest, are capable of turning out all the engines required for vessels built at South Bank and Stockton, as well as meeting all possible demands for engine repair work. This company is one of the pioneers in welfare work, and many of the visitors found much of special interest in this section of the works.

Another large party took the opportunity of visiting the Teesdale Iron Works of Messrs. Head, Wrightson and Co., Ltd. These works had their origin in a small iron foundry about the year 1840. The present limited company was incorporated in 1890, and in 1897 the company acquired the Stockton Forge Works and the Egglescliffe Foundry, Stockton-on-Tees. Many extensions have been made since, the latest being a foundry for the manufacture of steel castings by the electric furnace process. Manganese steel is one of the specialities, and it is manufactured extensively for jaw faces, hammers, liner plates, plough points, links, etc. The iron foundries are capable of an output of approximately 1,500 tons per week, and the steel foundries 200 tons per week. The works visited comprised the bridge yard, wagon and constructional department, machine and fitting shops, smith shop, pattern shops and foundries. The specialities manufactured by this firm include bridges, piers, dock gates, floating docks, roofs, wagons, tube mills, complete blast-furnace plants with patent charges, iron and steel works plants, coal shippers, loading and discharging plants, tanks, tunnel, segments, ingot moulds, railway chairs, slippers, etc., and at the Stockton forge works every description of colliery and mining plant. Under normal conditions about 3,000 people are employed.

On the Thursday the Clarence works of Dorman Long and Co., Ltd., were available for inspection, and a party was received by Mr. E. D. Morgan, the general works manager. These works were acquired by the company in 1923 on their amalgamation with Bell Bros., Ltd. The first

three blast furnaces at the Clarence works were blown in 1854, and made 12,536 tons of iron in the first year. Now the capacity of these works is 350,000 tons of iron per year. In addition to the old side-blast-furnace plant, the works include the new side-blast-furnace plant of four furnaces and two batteries of coke ovens—72 Collin regenerative ovens and 84 Otto waste-heat ovens,—both of which work in conjunction with Baum coal washeries and crude by-product recovery plants, and supply coke to the blast furnaces. The steel melting shop includes one 400-ton tilting metal mixer, and nine basic open-hearth fixed furnaces, of a capacity varying from 70 and 80 tons. The rolling mills consist of a 32 in. three-high rail and billet mill, comprising cogging, roughing, and finishing stands, with a capacity of 3,500 tons per week, and rail-bank and finishing accommodation from 2,500 tons of finished rails per week. In addition, there is an up-to-date coal distillation plant for the further refinement of by-products. The party were particularly interested in the hematite iron used in the manufacture of ingot moulds, and inspected No. 2 foundry, which is used solely for the manufacture of ingot moulds, ranging from 30 cwt. up to 10 tons capacity. This foundry has an output of 350 tons per week, and is efficiently organised to maintain this output.



A Blast Furnace Plant at Messrs. Dorman Long & Co.

In connection with the blast-furnace plant, it was of interest to note that the coke was brought in a skip direct from a battery of coke ovens situated immediately behind the furnace to be charged. In No. 1 foundry, which has a capacity of 100 tons per week, the general castings are made. Green-sand moulding predominates, and the good finish produced on the castings was commented upon. An interesting feature in this foundry is the use made of coke-oven and blast-furnace gas for the drying of moulds and heating of core ovens. The party had a very interesting time watching the manufacture of steel at the steelworks, where special steel and high-carbon steels are a speciality. Some idea was gained of the rough usage to which ingot moulds are subject. The whole process of the manufacture of rails was witnessed from the steelworks through the various mills, and finally through the finishing mill.

In these works much attention is given to the by-products and all the residuals of the coke ovens of the Dorman-Long group of works are dealt with in a special by-products plant. In addition, the party witnessed the working of the sulphuric-acid plant, which operates on the concentration process. At the conclusion of the visit, Messrs. Dorman Long and Co. entertained their visitors to tea, completing an interesting and informative afternoon.

During the same period another party made a visit to the works of Messrs. Richardsons Westgarth and Co., Ltd. These works were originally the property of the Hartlepool Iron Works, but some years ago efforts were concentrated on the manufacture of marine engines. They cover an area of some fifteen acres, the major part being occupied by modern well-equipped shops arranged for manufacture of steam reciprocating engines, oil engines, steam turbines, boilers, condensing plant, and alternators. The company has, within the last few years, been developing an oil engine of their own design which has necessitated the adoption of machines capable of working to very fine limits, the cylinder-grinding machines alone being an item of considerable interest. Although the company's name is more intimately associated with marine work, it is interesting to note that steady progress has been made with land work, and the firm is now in a position to take contracts for complete equipment of land power stations. The iron foundry, which proved of special interest to a large number of visitors, is equipped with three cupolas, and is capable of turning out castings up to about 40 tons in weight, with a weekly output of approximately 100 tons.

Probably one of the most interesting visits was that made to the works of the Imperial Chemical Industries, Ltd., at Billingham.

The aim of these works is the ambitious one of making the Empire self-supporting in the fields of nitrogen and other fertilisers. The object is being achieved, and Billingham to-day is producing more than enough nitrogen compounds to supply all the Empire's requirements for fertilisers and explosives. It was in 1919 that Brunner Mond and Co., Ltd., and the Synthetic Ammonia and Nitrogen, Ltd., took up the scheme to manufacture synthetic nitrogen. They purchased the Billingham site, about 800 acres of bare land, and on it erected a laboratory, with a complete model synthetic ammonia plant. The works have now grown into one of the greatest fertiliser factories in the world, giving regular employment to many thousands of workers. The large party that visited these works quickly recognised the enormous achievements made in so short a time, both in engineering and chemistry, and many favourable comments were made, particularly in connection with the engineering and machine-shop, which was spoken of as one of the finest in the North of England.

In every instance the members of the Institute who joined in these visits were much impressed by the cordiality of their reception at the various works, and words of praise were expressed to the organisers, and particularly to the works executives, for the opportunities presented to them to ask questions in connection with any process that interested them particularly.

Beilby Memorial Awards.

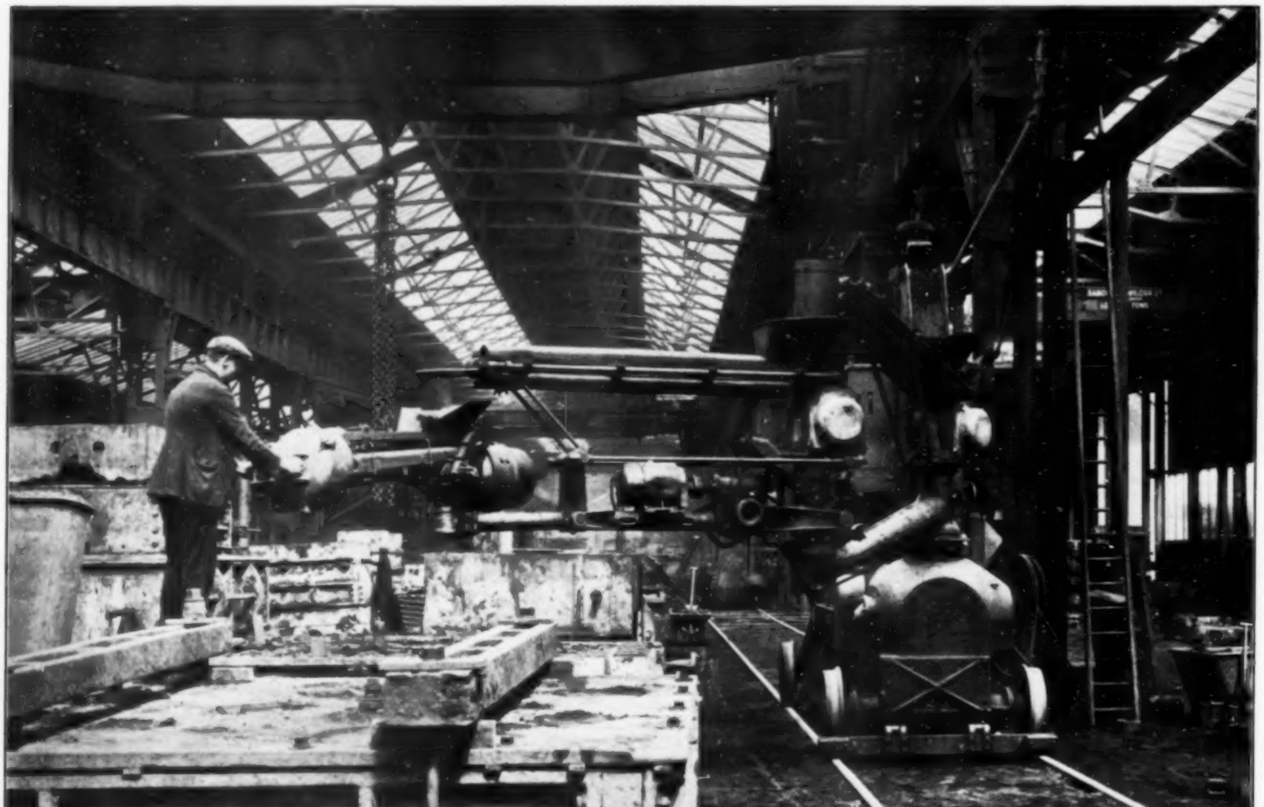
As a memorial to the late Sir George Beilby, the distinguished chemical engineer, who died in 1924, a fund was collected in 1926 from the interest on which, at the discretion of the administrators, awards are to be made from time to time to British investigators in science, to mark appreciation of distinguished original work carried out over a number of years, preference being given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering, and metallurgy.

The administrators of the fund are the Presidents, Treasurers, and Secretaries of the Institute of Chemistry, the Society of Chemical Industry, and the Institute of Metals, and they have announced the award of £250 each to Dr. Guy Dunstan Bengough, of the Chemical Research Laboratory, Teddington, and Mr. Ulick Richardson Evans, of Cambridge.

Progressive Foundries Secure Work in Lean Times

IN normal times there is generally sufficient demand for castings to maintain all the foundries in this country, and while some may not produce on a 100% capacity basis, they are nevertheless kept tolerably busy. In such times economic production is relatively of less importance, and time of delivery becomes a primary factor. Foundries producing their highest capacity are unable to guarantee delivery so readily, or cannot fulfil requirements because of pressure of business, and thus work is spread over a wider area, and all foundries participate. It is during times of depression that competition becomes keener, and while some foundries continue to obtain orders that maintain production on a high percentage basis, the large majority suffer from depleted orders. Those who are suffering from want of business will, if they are wise, make searching inquiries into the reasons why some foundries remain busy. Many factors must necessarily be considered in their review. It is a remarkable fact that where initiative and development have been displayed by foundry executives, such foundries are producing nearer to their capacity basis. A progressive and constructive policy, combined with systematic research, constant experiment, practical tests, modern plant and modern methods of production, tested materials, and skilled workmen, makes the products of the foundry outstanding in regard to cost, reliability, and performance. Building and laying out modern plant for a new foundry have many advantages, but very old foundries that have been developed in line with progress are practically in as good a position to cope with work economically and well. The old foundries are not necessarily a bar to progress There are, unfortunately, many that have not changed during the last thirty years; but where real advancement has been effected by development and the installation of modern equipment, they are able to quote on a more competitive basis and secure orders which keep the foundry busy even in dull times.

We can only refer here to a few firms that have regularly been producing a high percentage of castings in comparison with their normal output. One of the oldest foundry buildings that may well be mentioned is the Salford Iron Works of Messrs. Mather and Platt. The building is well over 100 years old, and although formerly used as a machine shop, it has been converted into what might be termed a large foundry, producing on an average 100 tons of castings per week. It is equipped with three cupolas. Two are 5 ft. 3 in. diameter at the melting zones, and each is capable of a normal output of 10 tons per hour.



Motive Type Sand Slinger with 17 ft. 6 in. radius. Installed at Messrs. Mather and Platt.

These are used for ordinary compositions suitable for general machinery castings. A smaller cupola with an internal diameter of 2 ft. 3 in. at the tuyères is used solely for special alloy compositions which have been successfully developed for castings involved in various kinds of chemical engineering. Limited for space and unable to expand, the charging platform has been remodelled and enlarged, and now accommodates a large stock of various brands of pig iron, scrap, coke, and flux. It is fitted with an electric runway which is capable of raising the raw material direct from wagons and also scrap from the foundry floor. It is used for lifting and weighing the charges and delivering direct to the cupola. The tipping device is ingenious, and has been designed and manufactured by the firm. It is entirely under the control of the operator of the crane, who by means of a stopping device unbalances the skip and causes the charge to be thrown into the cupola.

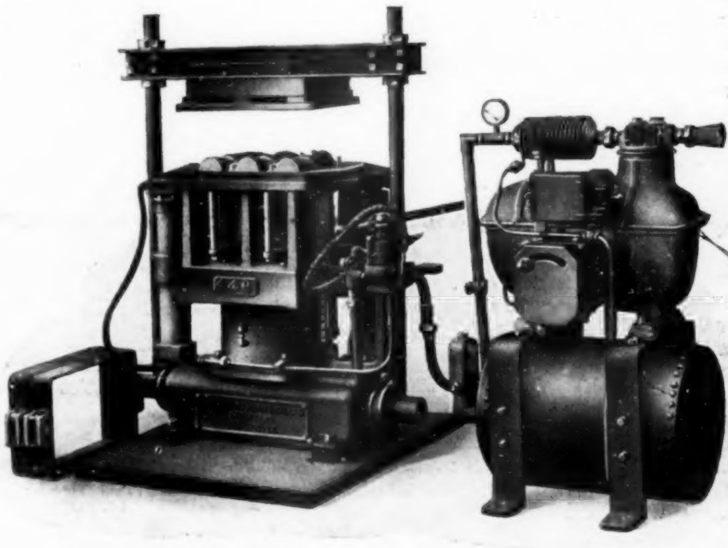
An interesting feature is the sand-preparing plant, which, due to the height of the building, has been erected on a special piatform above the floor level. Sand is deposited on a convey r under the floor level, and elevated to the platform to be prepared. The prepared sand is subsequently stored in bunkers, placed over a battery of jarr-ram turn-over moulding machines, from which it is delivered to the machines. The supply of sand is controlled by the operator of each moulding machine, and operated by compressed air through chutes. The moulding machines are arranged for comfort and convenience in operation, and, incidentally, for economical production. Every effort has been made to limit the amount of heavy work so common in the majority of foundries. Plain jarr-ramming machines are placed conveniently for general use, so that moulds may be rammed mechanically as required. The lifting and transporting equipment is a remarkable feature, not because of its modern character, but because in no part of this foundry is it necessary for a man to exert himself by lifting or carrying—a runway jib, or travelling crane is always at his disposal.

In order to cope with the larger work beyond the capacity of the moulding machines, a Beardsley-Piper motive-type sand slinger has been installed. This is the most outstanding development in the sand-slinger application to the industry in this country. It carries on its own truck a tank with a slot-feed bottom, having a capacity of approximately 10 tons of sand. The truck travels at approximately crane speed, and the radius arm of the slinger covers up to 17 ft. 6 in., or a diameter of 35 ft. The machine is operated entirely by electric power, and by the introduction of a variable-speed impeller head the machine will produce moulds in 16-in.-square boxes, or in the largest size of box found in the average foundry. Five motors are housel to give the various movements. The tractor, impeller, elevator, and hopper bottom, arm-raising gear, and the belt conveyer are each served with a separate motor, and each is under the control of the operator at the impeller head.

The foundry floor has been arranged to take full advantage of this machine, rails having been laid the full length of the shop, and the preliminary work of filling moulding boxes with sand to the required density is readily accomplished within the range of the impeller head, ample facilities be ng available for transporting the rammed moulds to another part of the foundry for stripping. This enables the machine to be used as much as possible, as other moulds can take the place of those rammed and removed. The operations of the machine have been so successful that many medium-sized castings formerly cast in moulds prepared in the floor are now cast in boxes.

Green-sand moulding predominates in this foundry, and many castings of three and four tons weight are cast in moulds that have merely been skin-dried. A number of August's portable driers are installed that are easily moved to any part of the foundry for skin-drying, or more completely drying in cases where dry-sand moulds are considered advisable. These portable driers are coke-fired, and hot air is distributed in the mould by means of a fan integral with each dr er. Stoves are, of course, available for drying cores. This foundry can hardly be classified as a mass-production foundry, as a very wide range of work is produced, the castings varying in weight from a few pounds to many tons, and the foundry executives are more than satisfied with the economical results of the developments. Mixtures are controlled by a qualified metallurgist, and tests of the metal resulting from them are carried out in a well-equipped laboratory.

Mention may be made of the developments in the foundry of Henry Wallwork and Co., Ltd. Here, again, the installation of complete and modern equipment, coupled with searching and efficient control of processes, has placed the firm in a favourable position to compete for orders, and their success is reflected in the fact that they continue to produce almost at full capacity when orders are difficult to obtain. The range of castings is not so great as in the former instance, but, from the point of view of intricacy, the castings produced will compare with most foundries. Great dependence is placed upon green-sand work, and every care is taken to produce castings that will bear close inspection, possessing, as they do, an excellent skin. Moulding machines play a prominent part in the system, and a number of Zimmerman machines have been installed which have many interesting features, combining jolt-ramming with a squeezer device, and mechanical stripping with turnover facilities. But this firm have built moulding machines to their own design, suitable for coping with the wide range of work produced, and batteries of these machines are installed. They are of the jolt-ram type, and are fitted with a presser head and stripping device. Oil sand cores are used to a considerable extent, and a special room is set apart where girls prepare the cores, which are baked in a special oven under temperature control.

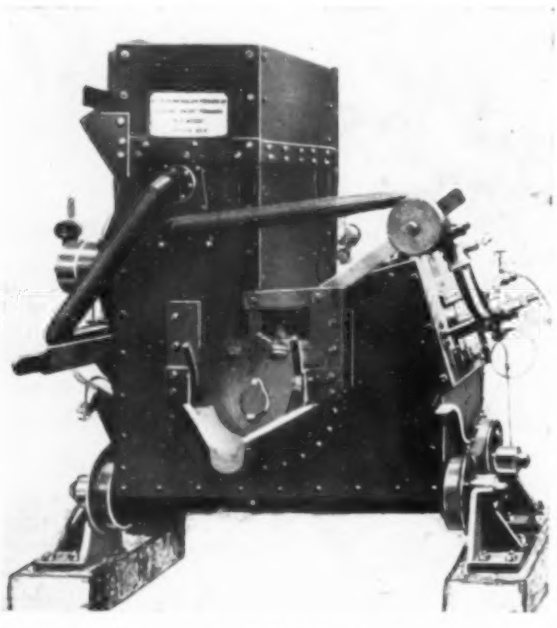


Moulding Machines designed, manufactured and used in the works of Henry Wallwork and Co., Ltd.

Many castings are comparatively thin, and necessitate hot metal, and while the cupolas are operated with this in view, the ease by which the ladles of metal are conveyed from the cupolas to the casting floor facilitates their production. Considerable attention is concentrated on the

inspection and cleaning of the castings. Sand-blasting apparatus of the Tilghman types are installed, including cabinet and rotary barrel machines which are operated under an air pressure of 30 lb. Grinding wheels arranged in series deal with further cleaning necessary, and each casting is carefully inspected, and only visibly perfect castings allowed to pass. The system adopted has obviously been developed as a result of experience covering the range of work within their scope.

In the non-ferrous field a conservative spirit seems to prevail in many foundries, which is inimical to progress. Modern development conveys little if it is not applied to produce better articles at lower cost, and vision is required to explore their possibilities. A notable example of foresight in this respect is indicated by the enormous progress made by John Holroyd and Co., Ltd., during recent years, who have considerably increased their turnover as a result of foundry development. Impressed with the need for better casting, and being courageous at a time when pessimism was becoming a predominant industrial feature, this firm determined to modernise their foundry. It is primarily concerned in the production of bronze castings, and phosphor-bronze is one of their most regular compositions. Careful attention is given to the selection of the raw materials, particularly the virgin metals, alloys, and scrap used in preparing the various compositions. All mixtures



300-lb. Oil-fired Furnace, by British Reverberatory Furnaces Ltd., installed at John Holroyd and Co., Ltd.

are prepared and cast into ingots, to be used subsequently for making up charges for the furnaces. Machine scrap, after passing through a magnetic separator to remove iron, is melted in 1,200-lb. charges, which are afterwards analysed to determine accurately their composition; these are tabulated and used as circumstances permit. The melting plant has been installed for dealing with 8 to 10 tons of metal per day, and yet give that flexibility desirable in a non-ferrous foundry where many compositions may be required in one day. The plant consists of three coke-fired reverberatory furnaces, each of 1,200 lb. capacity. These are manufactured by the British Reverberatory Furnaces Ltd., and each melts a full charge in about an hour, working on a fuel-metal ratio of 1 to 4. An interesting feature is the manner in which the fumes are exhausted from them. The firm recognised the possibilities of the waste heat, and constructed a core oven through which the heat is conveyed before it is exhausted to a chimney. Adequate heat is thus obtained for a good proportion of cores made in the work. A more recent furnace addition is an oil-fired furnace of 300 lb. capacity, which was on exhibition at British Industries Fair at Birmingham last February. An impeller in the burner is operated by air from a fan, and atomises the oil. The air used is pre-heated by waste heat from the furnace. This furnace melts a full charge in about twenty minutes. A Morgan's crucible tilting furnace of 250 lb. capacity is also installed. This is fired by coke, and is supplied with blast from a fan integral with the furnace.

The moulding sand is prepared by means of a portable machine, and the core sand in a Jackman's mixer. Some ingenious core-making machines have been designed and manufactured by this firm for making worm-wheel cores. Quite a number of various types of moulding machines are installed, and the metal is conveyed by a Morris runway, while heavy loads are transported by Royce's electrical travellers, two of which are employed. Full compressor equipment for moulding machines and sand blasting is installed, and the sand-blast apparatus includes a single nozzle cabinet and a double nozzle rotary barrel manufactured by Tilghman, and a Jackman rotary barrel appliance with one nozzle.

Considerable experimental work has been carried out by this firm in regard to centrifugal casting, and at present special plant is being laid down for producing worm gear castings by this process. The results from their experimental work have been such that production on a more comprehensive basis is likely to ensure a grade of casting of the highest quality. In addition, a department is being prepared for the chill casting of rods. The equipment installed is to the latest designs, and the transport of the metal is fully assured by means of Morris runways, which are erected between the furnaces and moulds. They are arranged to run between rows of moulds, so that castings can be poured on each side.

The introduction of modern methods has practically doubled the number of workers in this foundry, which apparently indicates that bold measures, combined with a progressive and constructive policy, are valuable in dispelling the gloom of depression by increasing the possibilities of the foundry industry.

Society of Chemical Industry.

For the first time for more than 20 years the Society of Chemical Industry is holding its full annual general meeting and congress at Birmingham. This is taking place throughout the week beginning July 14, under the presidency of Dr. Herbert Levinstein.

Besides the usual ceremonies associated with the meeting the programme will include visits to various works, among them being those of Messrs. Cadbury Bros., at Bournville, and Messrs. W. and T. Avery, Ltd., at Soho Foundry.

The Messel lecture will be delivered by Lord Brotherton, this year's recipient of the coveted Messel medal, the Society's award for services to the chemical industry.

During the meeting the election of Lord Melchett as next year's President of the Society will be confirmed.

New Appointments.

The directors of Palmers' Shipbuilding and Iron Co. Ltd., have appointed Mr. Alfred Kemney manager of Messrs. Hawthorn, Leslie and Co.'s dock department, as general manager of their Hebburn and Jarrow docks department in succession to Mr. J. McGregor, who has been appointed manager of Palmers (Swansea) Dock Co.

Mr. T. Fleming, who belongs to Hebburn and has been with the Hull Central Dry Dock Co., has been appointed outside manager at Palmers' dock department, Hebburn, and has commenced his duties.

We understand that Mr. D. E. Grant, who has for the past six years been at Elswick Works, Newcastle-on-Tyne, in charge of the Close Works Iron Foundry, Steel Foundry, and latterly of the Drop Stamping and Forging business, now part of the English Steel Corporation, has been appointed Managing Director of Messrs. Dixon and Corbitt and R. S. Newall and Co., Ltd., of Gateshead-on-Tyne, the well-known hemp and wire-rope manufacturers.

The International Congress of Mines, Metallurgy, and Applied Geology at Liege, and the International Foundry Congress

By A Special Correspondent.

The organisation of this Congress, at which more than 200 papers were presented dealing with practically every phase of mining, metallurgy, and applied geology, must have been a stupendous task, and the excellent manner in which it was accomplished reflects great credit upon the various Committees responsible.

THE Sixth International Congress of Mines, Metallurgy, and Applied Geology was held at Liége from June 22 to 28, 1930, and was attended by some 1,500 delegates from all parts of the world, including 200 official representatives of Governments, Scientific and Technical Societies and Universities. The British official delegates included Dr. Seligman, President of the Institute of Metals; Professor Henry Louis, President of the Iron and Steel Institute; Sir Holberry Mensforth, representing the Institution of Mechanical Engineers; and Sir A. E. Kitson, representing the Geological Society.

More than 200 papers were presented dealing with every phase of mining, metallurgy, and applied geology. In order to deal adequately with these papers the Congress was organised into sections and sub-sections. The Metallurgy Section included sub-sections on Blast Furnaces, Steels and Alloy Steels; Foundry Practice; Non-Ferrous Metals; Non-Ferrous Alloys and Fuels. Certain meetings and social functions were common to all sections of the Congress. A feature of the social activities was the very complete arrangements made for the entertainment of ladies. Works visits were arranged to many of the large factories in the neighbourhood of Liége, and all the delegates took advantage of the opportunity of visiting the International Exhibition now being held in that city. Meetings of the Congress were held at the University of Liége.

The Congress was officially opened on Monday, June 23, by the President, Professor Fourmarier, who mentioned that the fourth Congress was held at Liége 25 years ago, and that this sixth Congress was held under the patronage of H.M. King Albert the First. Addresses were presented on behalf of the foreign delegates by Monsieur Guillet, representing France, and Signor Martelli, representing Italy, and other foreign representatives. On the adjournment of the meeting the principal delegates were entertained to luncheon. Later in the day the various sections met in different parts of the building for the presentation and discussion of papers, whilst the Foundry Sub-Section paid an official visit to the Exhibition. In the evening a reception was held at the Hall of Fêtes, in the south sector of the Exhibition, at the invitation of the Mayor and Aldermen of Liége.

The Foundry Sub-Section of the Congress was particularly important, as it formed one of the series of the International Foundry Congresses which are held annually in various countries. Three hundred of the delegates were definitely attached to the International Foundry Congress, which was opened on Tuesday, June 24, by Monsieur J. Leonard, President of the Association Technique de Fonderie de Belgique. The British representatives included Messrs. J. Cameron and V. C. Faulkner, Past-Presidents, and Mr. T. Makemson, General Secretary of the Institute of British Foundrymen.

After the delivery of the presidential address, the remainder of the morning was devoted to the reading and discussion of papers dealing with the general subject of the testing of iron. Professor H. Thyssen, of the University of Liége, presented a report prepared by the Association Technique de Fonderie de Belgique, dealing with the shear test; he also presented a paper, prepared by himself, dealing with the general testing of iron; and a third paper, by Professor Thyssen and Monsieur J. Bourdouxhe, described a new testing machine designed for the purpose of testing small test pieces taken from the casting.

A very comprehensive paper by Professor Pisek, of Brno, Czechoslovakia, gave comparative results of different methods of testing. The shear test by the "punching" method was discussed in a paper by Monsieur A. Deleuse. Two papers dealing with other subjects were also presented at this session, namely, a review of the existing practice in the production of electrolytic iron by Monsieur R. Dupuis, of Milan, and a paper by Mr. J. W. Deschamps, of Letchworth, England, on the comparative advantages and disadvantages of the various processes employed for the production of steel in steel-foundry practice. This last paper was the official exchange paper presented on behalf of the Institute of British Foundrymen.

The afternoon of June 24 was devoted to works visits, a very large number of the delegates taking the opportunity of inspecting the famous works of the Sociètè Anonyme John Cockerill. Other parties visited the Ourgee-Marihaye works and the Usines à Tubes de la Meuse.

The famous Cockerill works were founded by a Britisher in 1817, and now employ upwards of 10,000 workmen. The plant includes seven blast furnaces with a total output of 1,200 tons every 24 hours. In the steelworks are five basic converters, each of 15-tons capacity; four open-hearth furnaces, each with a capacity of 15 to 25 tons; and two electric furnaces of 5 and 12 tons capacity, respectively. The converters are supplied with iron direct from the blast furnaces.

The iron foundry is one of the largest in Europe, and the five cupolas have a total melting capacity of 40 tons per hour; the iron and steel foundries produce 20,000 tons of castings per year. The products of the firm include artillery, ordnance, locomotives, and large blast-furnace gas engines.

At the second session of the Foundry Congress on the morning of Wednesday, June 25, a number of papers were presented on the general subject of special irons. Certain papers on miscellaneous subjects were also presented, including an interesting short paper on the application of fluor spar in the cupola, by Monsieur Deuvorst, of Ulft, Holland, and an exhaustive review of furnaces for special iron-foundry practice by Dr. Geilenkirchen, of Dusseldorf. Reference was made to the application of reverberatory and open-hearth furnaces, both fixed and rotating, and pulverised-fuel firing was also discussed. The papers on special irons included another British paper, the author of which was Dr. A. L. Norbury, of the British Cast-iron Research Association. Dr. Norbury discussed the factors influencing the properties of special irons and the influence of melting methods and the chemical composition. An exhaustive paper on the effect of nickel in cast iron was submitted by Monsieur F. Renaud, and Monsieur Le Thomas, the well-known French metallurgist, was the author of a paper dealing with "Some Physico-Chemical Modifications of so-called Pearlitic Cast Irons." Other

papers presented at this session included a review of recent progress in the production of high-tensile irons by Monsieur R. Lemoine, of Paris; and a very valuable short paper on blast pressure and volume in cupola practice was given by a Spanish author, Senor J. Canameras-y-Gonzalo.

On the afternoon of June 25 the delegates from all sections of the Congress visited the laboratories of the National Arms Factory, Herstal.

The Malleable Iron Foundry session of June 26 was well attended, and evoked considerable interest in view of the advances which have been made in Europe in malleable iron-foundry practice in recent years. Dr. Stotz, of Dusseldorf, reviewed the application of pulverised fuel in malleable iron-foundry work in Germany, dealing particularly with pulverised-fuel furnaces of the rotating type. An interesting review of the evolution of malleable foundry practice in recent years in the French Ardennes was presented by Mr. Raymond Gailly; a similar paper on malleable foundry developments in America was given by Mr. H. H. Schwartz, of Cleveland, U.S.A.; whilst Professor Piwowarsky, of Aix-la-Chapelle, presented a general review of recent progress. Mr. R. Deprez, Secretary of the Belgian Foundrymen's Association, was the author of a useful short paper on the history of the malleable iron-foundry industry in the Liége district. Other papers dealt with in this session included a review of Italian practice in the manufacture of light alloys, and a paper on simplified practice in metallography by Monsieur Girardet.

The concluding session of the Foundry Congress was devoted principally to the testing of moulding sands, papers being submitted by Mr. H. W. Dietart, of Michigan, U.S.A., and M.A. Deleuse, of the Belgian National Arms Factory at Herstal. At this session a paper on the temperature and air conditions of foundry stoves was given by Mr. A. Debar, and a report was submitted on standardised practice in pouring pulleys and fly-wheels. This report was prepared and submitted by the Scientific Commission of the Belgian Foundrymen's Association.

At the closing session of the International Congress of Mining, Metallurgy, and Applied Geology, the President, Professor Fourmarier, gave an extensive review of the trend of modern progress in various branches of the sciences dealt with at the Congress. Dealing with modern tendencies in metallurgy, he said that in the manufacture of iron the present practice was towards the construction of blast furnaces of large output and the more complete utilisation of by-products. In steel manufacture he cited the development of the electric furnace, the increasing attention being given to research and the increasing importance of scientific methods of heat-treatment. Recent progress in alloy steels was also mentioned. A notable tendency in non-ferrous foundry practice was the increasing application of light alloys, and the attention which was being devoted to the development of alloys to resist corrosion; progress in electro-deposition was also reviewed.

Dealing with fuels, the President referred to the employment of briquettes and other prepared fuels, and the utilisation of by-products. Modern tendencies in foundry practice included the standardisation of testing methods for the control of iron and sands, the study of the influence of various foreign elements, and the modernisation of the processes of manufacturing malleable cast iron.

On Wednesday evening, June 25, a banquet was held in connection with the Congress at the Hall of Fêtes in the northern sector of the Exposition, and on the following evening the closing banquet of the International Foundry Congress was held at the Restaurant Continental. Speeches were delivered by Comm. C. Vanzetti, of Milan, Monsieur Damour, of Paris, respectively President and Vice-President of the International Committee of Foundry Technical Associations, representatives of all the nations present also spoke; the greetings and thanks of the British delegates being voiced by Mr. John Cameron, Past-President of the Institute of British Foundrymen.

Friday, June 27, was mainly devoted to excursions. Certain sections of the Congress combined business with pleasure by visiting works situated at a distance from Liége. The delegates to the International Foundry Congress took part in an automobile excursion to Spa.

The International Exhibitions at Liége and Antwerp are being held concurrently, and together are fully representative of manufacture, art, and scientific achievement. In view of the character of the industries of the district, of which Liége is the centre, the Liége Exhibition is naturally devoted principally to the metallurgical and engineering industries, although other industries are well represented.

An inspiring collection of metallurgical plant and manufactures is housed in the Pavilion of Metallurgy. Many of the manufactured articles such as rolls, rolling-mill housings, and ingot moulds are destined for use in the manufacture of iron and steel. Rolled sections for constructional work, steel rails, sleepers, tubes, cast-iron pipes, forgings, and castings are also on view. The whole of this section is a wonderful display of the products of the forge and foundry.

The firms represented are mainly Belgian. The Société-Anonyme John Cockerill has the largest stand in the section. This firm exhibits a cylinder and also a crank-shaft for a 10,000 h.p. blast-furnace gas engine. A turbo-generator set and examples of ordnance are also shown. The Esperance-Longdez, Ougrée-Marihaye, and Angluer-Athus firms are also well represented. Messrs. Thomas Firth and Sons, who are one of the few British firms in this section, have an attractive stand devoted to the applications of "Staybrite."

The Machine Tool Section adjoins the Pavilion of Metallurgy. Almost every type of machine-tool and wood-working machine is exhibited, mainly by Belgian and German firms, although a prominent position is occupied by a British firm, Messrs. William Asquith, of Halifax, who show a selection of drilling machines.

The Civil Engineering Section contains a considerable amount of excavating and conveying plant, another British firm, Messrs. Ruston-Bucyrus, being represented in this section. A good deal of machinery is on view in other sections, including printing machinery by Messrs. Linotype and Machinery, Ltd., of Altrincham.

Locomotives and rolling stock are shown in the Transport Building, and an interesting exhibit showing the development of the modern motor-cycle is housed in the Motor-cycle Section.

A number of foreign countries are represented by separate pavilions devoted to their respective manufactures. These national pavilions also contain many exhibits of engineering and metallurgical interest. Locomotives and rolling stock of Italian construction are shown in the Italian Pavilion, and castings and forgings are displayed on several stands in the French Pavilion. In this building there is a collective exhibit of castings arranged by members of the Syndicat Général des Fondeurs de France, and a similar joint exhibit staged by the Syndicat Général des Fondeurs de Belgique is shown in the Metallurgy Section.

The Electricity Building contains a large amount of switch gear and control gear. Electric motors, electric domestic and scientific apparatus, radio, batteries, and lamps are also displayed.

The gallery of the Metallurgical Building is given up to a display of the work and methods of professional and trade schools. This section is an illuminating display of a type of vocational training which appears to have been developed to a much greater extent on the Continent than in this country.

It will be seen that the engineering and metallurgical displays are rather scattered, but, taken together, they form a very fine exhibition. Although many foreign firms are represented, the majority of the exhibits are Belgian, and the exhibition gives an impressive picture of the very high state of development of Belgian industry.

The Modern Blast Furnace and its Operation

By R. A. Hacking, B.Sc.

PART IV.

The Use of Dried Blast—Theoretical Considerations—Operating Results.

The whole of the water-vapour entering the blast furnace with the air blast via the tuyères reacts with the incandescent coke in the "combustion zone," according to the well-known "water gas" equation:—

$$H_2O + C = H + CO - 52{,}020 \text{ B.th.u's.}$$

Thus, 2,890 B.th.u's are absorbed per pound of water vapour decomposed. In gas-producer practice this reaction is utilised to control the temperature of the combustion zone, in order to regulate the composition of the gas, and to keep the fuel bed in satisfactory condition.

It follows that at any given blast temperature the number of B.th.u's available in the "combustion zone"

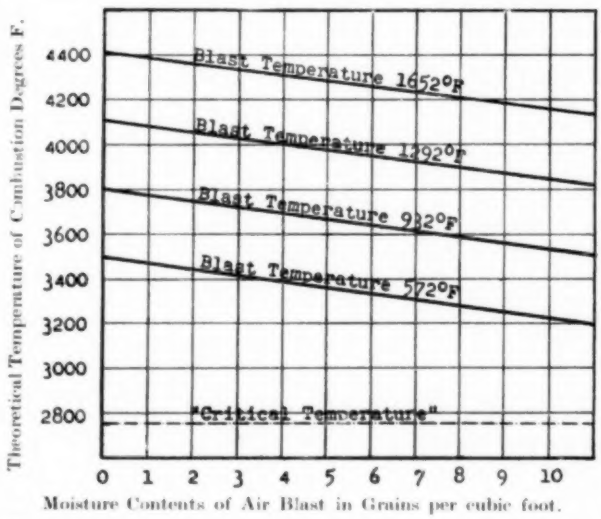


Fig. 4. Relation of Temperature of Combustion to Moisture Content of Air Blast.

of the blast furnace is decreased by an increase in the moisture content of the blast, since the sensible heat brought in by such moisture can never, within attainable limits of blast temperature, be sufficient to counterbalance the heat required for its decomposition. The graphs in Fig. 4 show the relation between the moisture content of the air blast and the theoretical temperature of combustion of pure carbon oxidised to carbon monoxide. The specific heats of carbon, water vapour, oxygen, nitrogen, and carbon monoxide, and the heats of formation of carbon monoxide and water vapour used in the calculations are those given by Richards. The air is assumed to consist of 23% oxygen and 77% nitrogen, by weight.

An increase in the moisture content of the blast of 1 grain per cubic foot thus lowers the theoretical temperature of combustion by approximately 23° to 27° F., the lower figure obviously corresponding to the higher range of blast temperatures in use at present.

The moisture content of the atmosphere in temperate climates, such as that of Great Britain, normally varies between 2 and 7 grains per cubic foot. In tropical or sub-tropical countries, moisture contents as high as 12 to 14 grains per cubic foot are attained during the rainy seasons. In districts with continental climates, such as the inland States of America, the difference between summer and winter conditions may be of the order of 10 grains of moisture per cubic foot.

A variation in moisture content of 3 grains per cubic foot lowers the theoretical temperature of combustion by about the same amount as a decrease of 80° to 90° F. in blast temperature. This variation is by no means an unusual day-to-day fluctuation, even in Great Britain. Thus, it is more than likely that many mysterious variations in operating results, such as alterations in quality of product, composition and character of slag, driving rate, etc., could be traced back to this cause, if continuous records of the moisture content of the atmosphere were available. On many plants, however, this important determination is often limited to one reading per day, and in some cases is entirely neglected.

Thus, the use of dried blast, or at least blast dried to a constant moisture content, facilitates considerable fuel economy, and leads to the elimination of a troublesome variable, with resultant improved control of the furnace operations.

Operating Results.

The difference between summer and winter operating conditions was observed on cold-blast furnaces as long ago as 1800, by Dawson of Lowmoor. The first serious attempt to overcome the difficulty, by utilising solid calcium chloride to absorb the moisture, was evolved by Fryer in 1880, but was not worked commercially. Since then several methods have been devised. These may be divided into two main classes—viz.:—

(1) *Absorption Methods.*—Calcium chloride was used in most of the early attempts (Fryer, 1880; Cremer, 1885; Elsner, 1906, etc.), various methods of re-activation of the wet chloride being devised. These ideas were modified by Daubiné and Roy in 1910, and a plant working on these lines was installed at Differdange Works, Luxembourg. The Harbord process utilised as the absorbent medium peat or pumice stone impregnated with calcium chloride or sulphuric acid.

In general, however, these early attempts at drying by absorption were found to be impracticable, on account of operating difficulties, and high running and maintenance costs.

(2) *Refrigerating Methods.*—In 1890 Gayley commenced his experimental work on refrigeration as a means for drying blast, and his work led to the installation of a refrigerating plant at the Isabella furnaces of the Carnegie Steel Company, and the publication in 1904 of the results obtained.

In his apparatus the expansion of compressed ammonia was used to refrigerate a solution of calcium chloride, which was circulated through cooling pipes in the path of the air on the intake side of the blowing engines. The air was refrigerated in two stages, the bulk of the moisture being removed as liquid water by cooling nearly to 32° F., and a further portion as ice by cooling below the freezing point. This method reduced the amount of refrigeration required by the latent heat of solidification of the large proportion of water removed as liquid, and operating difficulties in regard to handling and choking were largely avoided.

The original installation at the Isabella furnaces was

worked so as to give blast with a uniform moisture content of about 2 grains per cubic foot, and this practice led to a reduction in fuel consumption of approximately 320 lb. of coke per ton of pig iron, and the furnace output was increased by 80 tons per day. The operating records are shown graphically in Fig. 5.

Other plants subsequently installed in the United States, Great Britain, and on the Continent gave similar results. It was found, however, that the economies effected did not cover the high running and maintenance charges. In the case of the British plants, it became the custom to work them only during the summer months, and subsequently they were finally abandoned.

During the last few years the development of the Silica Gel process has placed at the disposal of blast-furnace operators a means for drying blast in which first cost, operating, and maintenance charges appear to be more than covered by the economies effected, even though the margin is only a few pence per ton of pig iron produced.

The use of Silica Gel as a medium for drying blast was suggested soon after its remarkable properties were described by Miller (American Institute of Chemical Engineers, 1920). Silica Gel has the chemical formula SiO_2, and is exceedingly porous, the innumerable voids in each individual particle being ultra-microscopic, and equivalent to 41% of the mass by volume. This remarkable degree of porosity results in a very large area of exposed surface per unit volume, and the "adsorbent" character of these surfaces, aided by capillary action, enables the gel to remove over 20% of its own weight of water from the air with an efficiency of 99% to 100%.

One of the difficulties with the early absorbent materials, such as calcium chloride, was that the process could not be made perfectly reversible, owing to the gradual deterioration of the dehydrating agent during the intermediate heatings necessary for re-activation. Silica Gel apparently does not suffer from this disadvantage, and by heating to about 640° F. is readily re-activated without deterioration, ready for the next cycle. Samples of gel used for several years for the adsorption of a variety of vapours show no signs of deterioration, and still possess their original adsorbent properties. Provided that adequate precautions are taken to exclude dust, the system can be made perfectly reversible.

A plant capable of dealing with 35,000 cub. ft. of air per minute has been in operation at the Wishaw plant of the Glasgow Iron and Steel Co., Ltd., during the last three years. The layout and operation of the plant were described by Lewis (J.I.S.I., 1927, II., and 1929, I.), the resultant fuel economy being estimated at 5·45% over twenty months' operation, with an increase in output of 13·27%. Part of these improvements may, however, be due to alterations in furnace lines.

One very interesting feature of the Wishaw practice was that drying to well below 1 grain of moisture per cubic foot led to a cooler hearth, the production of a whiter iron, and a falling-off in output. It has been found that the best results are obtained under the Wishaw conditions with blast dried to 1 to 1½ grains per cubic foot, and the air from the Silica Gel plant is diluted with natural air in order to maintain the moisture content at that optimum figure.

This apparently indicates that oxidation of the incandescent carbon opposite the tuyères is accelerated by the catalytic action of a small proportion of water vapour in the air blast, in a way similar to its influence upon the oxidation rate of other elements at various temperatures. Further, Bone, Reeve, and Saunders have shown that the reduction of the moisture content of blast-furnace gas increases the rate of reduction of the iron oxide, until a certain limiting value is reached. Below that moisture content the rate of reduction of the ore is enormously retarded. These phenomena agree with the operating results at the Wishaw plant.

The Silica Gel process has the advantages of low running and maintenance costs, and appears to be the first and only method for drying air blast, which shows a definite financial advantage. Its application to a coke blast furnace process in a climate more humid than that of Scotland is awaited with interest.

It might be contended that it is much easier and cheaper to raise the blast temperature 80° to 90° F. than to reduce the moisture content of the blast by 3 grains per cubic foot. In the case of most blast-furnace plants, especially those making low-silicon pig irons, the blast temperatures in use are considerably lower than those which could be attained with the existing stove equipment. This point has been referred to in a previous article. Thus, it appears that increased blast temperatures are the cheapest means to

(*Continued on page* 104.)

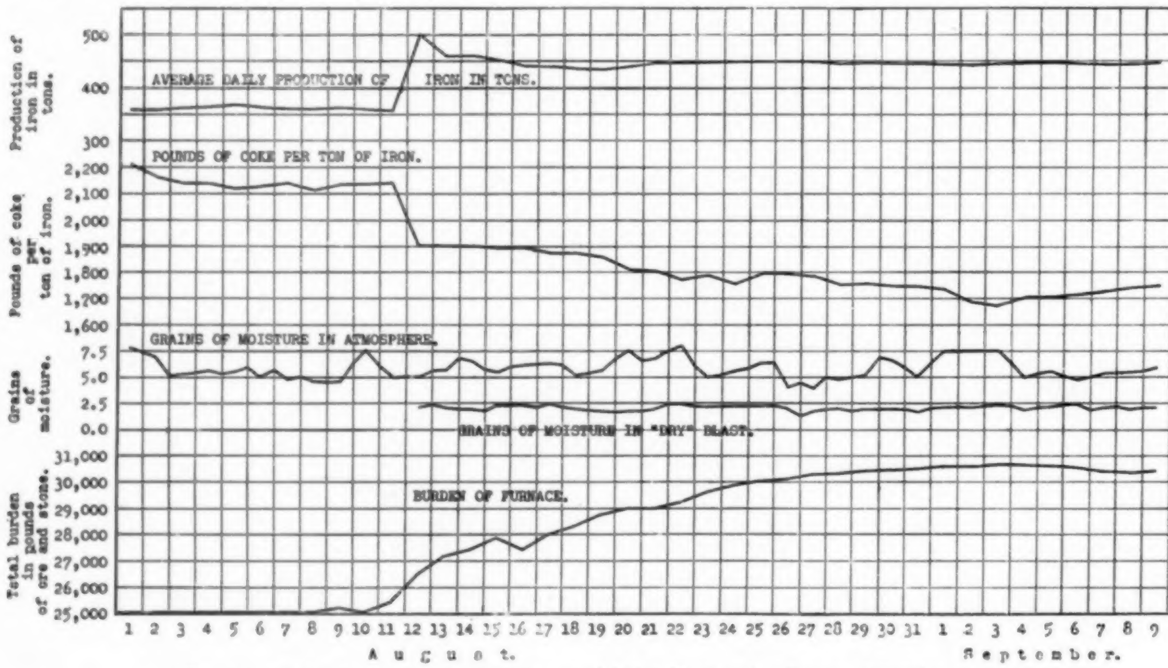


Fig. 5. Graphs showing the effect of the use of Dried Blast on the Furnace Operation (Gayley).

Malleable Cast Iron*

By J. V. Murray.

PART III.

Comparison of Melting Practices.

THE methods of melting malleable cast iron in order to produce hard, white castings is gradually undergoing a change. This is due to engineers, who very rightly demand high-class physical and mechanical properties in their castings. It is all to the good of the industry that this should happen, because it will yield that "reliability" which many have complained they cannot obtain. There appears to be no doubt within the minds of metallurgists that high-class malleable cast iron can be made and produced regularly. Makers of black-heart malleable claim to be able to do this easily; but makers and users of whiteheart complain very often that the castings are not what they should be. This has often led to blaming the pig iron used, and the change has been made to blackheart with more or less satisfactory results. There is no real reason that such a change should be made. High-class whiteheart malleable is just as easily made as blackheart.

To produce high-class material in malleable, the method of melting is of profound importance. Many firms have realised this, and in consequence have more than one method of melting. Generally speaking, there are three main types of melting :—

1. The crucible system.
2. The cupola furnace, and
3. The open-hearth air furnace.

Beyond the experimental stages are :—

4. The electric furnace, and
5. The rotatory furnace.

There are other systems of melting, such as :—

6. The duplex and triplex methods.

It is not the intention in this article to describe these furnaces. They are all well known with the exception of No. 5, which is a recent invention.

The Crucible Furnaces.—These are the oldest methods of melting known. As is well known, the furnace is a small, upright vertical chamber, square in section. The fuel of the furnace is coke. The most serious objection to this furnace is its limited capacity. One pot of metal is charged at a time.

These pots, or crucibles, hold only about 60—80 lb. of metal. Six charges per day is the maximum output. This method of melting is expensive in fuel and pots. Production is curtailed, and the metal deteriorates through long standing when hot.

It possesses a few advantages. The furnace does yield hot, quiet metal of consistent quality. Very few tools, and no machinery of any description is required. The melting is continuous. As a pot is taken out and poured, it can be immediately refilled whilst hot. The crucible system is best suited to a special type of moulding. For very thin castings, such as harness furniture, buckles, etc., or for small orders, where it would not be economical to make a plaster odd side of the pattern, this type of melting is very useful. For experimental research work it is, of course, invaluable.

The Cupola Furnace.—The cupola furnace has been looked upon with suspicion as being responsible for the many defects which occur in malleable cast iron, but if properly and intelligently worked it will yield metal of consistent quality very little inferior to crucible-melted metal. It is the particular furnace which calls for scientific control before any other in this type of iron. The cupola is the heart of the malleable foundry, and when working well everything is well; but when it goes wrong nothing is right, the business suffers accordingly, and one's reputation suffers with it.

The chemical composition of the charge alters from the beginning to the end of the blow. Whilst the cupola is the cheapest unit for producing molten metal it may easily become the most expensive. Charges should be weighed, not guessed. It has been found that the metal during its passage through will take up carbon up to about 3·45%. Higher carbon pig irons will give up by oxidation a portion of the carbon, but still will contain about the above amount.

Sulphur is always taken up according to the heat of the furnace, the amount in the coke, and the amount of manganese and silicon in the charge. Limestone will help to reduce the sulphur. Manganese is always oxidised to a certain amount, but silicon losses are greatest. Even the silicon loss varies. From 5% to 33% of total silicon may be oxidised. Under these conditions the charges cannot be guessed.

Another disadvantage is dead metal. There are two types of dead metal in cupola work. One is caused by sluggishness, due to the metal not being hot enough. In this state the moulds will not fill, and the faulty castings are easily detected. The other type is due to hot metal taking up carbon. In this state the metal lacks "sparkle" but runs finely, and it is possible that the castings get through. Upon annealing it will be found that these castings possess a black fracture in the centre, and upon being hit gently will fracture. A microscopic examination will reveal that flaky graphite is present.

A cupola working upon malleable will not run intermittently. The author once had occasion to visit a foundry where complaints were being made regarding the castings produced. It was found that the metal was being run "when required" by the moulders, and much of the metal when molten lay in contact with hot coke. Whilst no complaint could be laid upon the coke, which was of the best, or upon the metal, which was exceedingly hot, or even the castings, which looked perfect, it was found that the following changes had occurred in the iron used :—

	Silicon.		Carbon.
Pig iron..................	0·66	..	3·24
Casting	0·94	..	3·87

Obviously such changes turn white cast iron into grey. In this particular case silica had been reduced by carbon and taken up by the iron. This can and does happen when, towards the end of the day's run, the iron remains molten inside the cupola. Cupola metal needs tapping as quickly as possible when melted, and hot metal is required.

The special advantages of a cupola are its cheapness and adaptability. Speed in melting is unsurpassed. In 15 minutes from the time of charging the metal is ready to be tapped, and charges may be added as long as required. The composition of the charge may be altered to suit the castings if necessary. The furnace is easily kept in repair, and is cheap to maintain. The only necessary machinery is a blower, but scientific control is absolutely essential to ensure success.

*Continued from page 162, Vol. I.

Open-hearth Melting.—No sane malleable founder would install and use a furnace of this kind without proper supervision. The metallurgist is necessary here, and his influence can only be judged according to the rise of blackheart malleable. This has reacted against whiteheart founders. The open-hearth furnace is much more expensive than the cupola or the crucible. More refractory materials are required, and a charge cannot be varied. More fuel is required, but as this is either coal or gas, a comparison cannot be made against the cupola or crucible coke other than in costs. Although coke is about 50% to 85% dearer than coal the cupola has the advantage in fuel costs. The contents of the bath are under better control, and all is of the same chemical composition. Additions are easily made to the melt, and the heat of the furnace is also under control. A good casting temperature is attained, but the charge cannot be varied for a special casting. Pulverising plant, or gas producers, are required and blowing apparatus, too. Or, if a simple air furnace, labour is required for firing.

The special advantages are in the use of cheaper pig irons and the use of steel scrap.

By partial oxidation the silicon and carbon are reduced from about 1·20 to 0·8% in Si, and 3·87 to 2·80% C. These losses bring down the bath to that of a blackheart casting, and the oxidation increases the heat of the bath and furnace. Thus, a good super-heat is attained. Small quantities are, of course, impossible in an open-hearth furnace. The smallest type is usually about 4—5 tons. Ferro-alloys are very easily added to the metal when molten, and the whole of the metal must be run out when tapped.

The superiority of this metal is due to its inability to take up carbon under the conditions. There is also freedom from oxides, slag inclusions, and blow-holes, which are more prevalent in cupola-run metal. The melt is quiet, is of consistent quality, and is homogeneous when tapped.

The Electric Furnace.—This is the finest melting furnace yet evolved. It is the only type of furnace in which carbon is introduced, not for heating, but for addition purposes of performing chemical reactions. The malleable cast iron may be built up synthetically. The induction furnace is the one favoured generally against the arc types with the electrodes inside the furnace. The furnace itself is simply a large crucible built up with refractory and insulating material.

The temperature gradient is from the charged mass of borings, steel and pig outwards. That is to say, the bath of metal is the hottest part of the furnace and not the roof, sides, or melting zones, as in other furnaces. This effect stirs the molten metal, thus mixing the constituents well. Additions of carbon or other constituents are easily made by opening the furnace and shovelling them in. A slag may be run off, and a new one made because the furnaces are of the tilting variety. Tapping temperature is rapidly attained and easily maintained.

The only disadvantage at present is the higher melting costs.

The advantages may be summarised :—

1. There is a finer temperature control.
2. No deleterious gases are present to affect the melt.
3. Oxidising, reducing, or neutral atmospheres can be obtained at will.
4. Chemical reactions can be regulated by additions to the bath.
5. Any alloys may be added without loss.
6. The product is superior to the finest malleable produced by other methods.

The Rotary Furnace.—Quite recently there has been heralded a new type of melting furnace for which claims have been made that costs and quality of products are superior to anything yet produced. Mechanical tests have been sufficient to justify the makers to standardise these furnaces in sizes and capacity. The furnace consists of a cylindrical iron shell with tapered open ends, lined with refractory, and is horizontally fixed. It is not unlike the Bessemer converter, since it can be tilted to a convenient angle to allow the charge to be shovelled in or run down a chute. Machinery is provided whereby the furnace can rotate, and it may be placed upright to allow for relining with refractory. The fuel is pulverised coal, which is led to the furnace by means of a worm to the burners. Subsidiary machinery and plant such as a pulverising mill, storage bunkers, elevators, hoppers, etc., are necessary.

After charging the furnace is gently rocked to and fro, but when the charge melts it is completely rotated. The iron extracts the heat from the refractory lining and becomes intensely hot. The metal is so agitated that it is practically free from undissolved gases. This gives a finer-grained metal with a close texture, thus ensuring tough metal. The sulphur comes down to about 0·03%. The flame does not spray upon the metal surface but upon the refractory, and a definite length of flame becomes necessary to develop the full heat. The tapping is done by tilting the furnace.

Metal giving 28—30 tons per square inch is claimed, together with an elongation of 10 to 18% on 2 in.

This type of furnace is known as the " Bracklesburg " and is fully covered by patents.

Whether this type of furnace will supersede the cupola is a matter of time and demands by engineers. Sufficient evidence has been given in places to warrant a trial of this method and material by those interested in high-duty malleable.

The advantage claimed lies in costs of fuel, which is very cheap when compared with hard coal or coke. Against this may be charged the high cost of subsidiary plant and machinery which, of course, require attention. Refractory costs are bound to be higher than other furnaces. Speed of melting is slower than the cupola, but quicker than the open-hearth furnace.

Duplex and Other Methods.—These may be briefly tabled since they are only in the experimental stage at present.

1. Melted in the cupola and superheated in a forehearth or large ladle.
2. Melted in a cupola, run into a ladle, and mixed with converter steel, and reheated in an open hearth.
3. Melted in the cupola and transferred to the converter, blowing just sufficient to remove portions of carbon and silicon.
4. Metal from above transferred to the open hearth or electric furnace for suitable additions.

The objections to the above are simply those of costs, but malleable-iron founders in England are now trying these methods with the object of producing high-class material.

Melting methods in malleable are changing. Other furnaces are being designed, but all of them are planned on the principles of these described above. The demands of engineers for reliable malleable a e becoming more insistent. They cannot be resisted. Machines are now made to test the castings as against test-bars. The cry is for high-duty malleable iron, and the way to ensure it is to select the best method of melting.

IRON AND STEEL PRODUCTION IN JUNE.

THE number of furnaces in blast at the end of June was 133, a net decrease of eight since the beginning of the month, nine furnaces having been blown out and one having commenced operations.

The production of pig-iron in June amounted to 563,200 tons, compared with 614,500 tons in May and 657,800 tons in June, 1929. The production includes 171,700 tons of haematite, 227,900 tons of basic, 122,300 tons of foundry, and 21,900 tons of forge pig-iron.

The June output of steel ingots and castings amounted to 600,100 tons, compared with 691,900 tons in May and 830,900 tons in June, 1929. Part of the decline in the case of steel is due to the Whitsuntide holidays.

Alloy Cast Irons

By J. W. Donaldson, D.Sc.

The use of Nickel and Chromium has shown promising results, and their use is extending.

THE effect of the additions of special elements to grey cast iron and the production of alloy cast irons have received a considerable amount of attention during recent years. This has been due to the striking results produced by alloy steels, and the desire of the foundryman to produce similar results with cast iron. Investigations have generally been confined to the influence of small quantities of these elements, partly due to their high cost, and partly due to difficulties experienced in melting and casting. The result has been that much of the work has been carried out in the laboratory and little on a practical scale.

The object of most of these investigations has been to determine the influence of added elements on the physical and structural properties of cast iron. A fair amount of data has been determined dealing with the deoxidising, grain refining, hardening, and strengthening influence of alloy additions, but it is difficult to assess a value to it, as many of the investigations have been carried out by different workers under varying conditions, working on varying qualities of cast iron, and in some cases on inferior irons. More recently, however, investigations have been undertaken in a more systematic manner, using as a basis cast irons of good properties, and endeavouring to improve those properties by alloy additions. The elements which have shown the most promising results are nickel and chromium, and the use of alloy irons containing those elements either separately or conjointly is extending.

Nickel in Cast Iron.

Experiments on the influence of nickel on grey cast iron have been numerous. The earliest work is that of Keep,[1] who came to the conclusion that small additions of nickel under 1% are of no advantage. Guillet[2] found, however, that nickel caused precipitation of graphite, and this graphitising effect was confirmed later by Thaler,[3] Hatfield,[4] and Campion.[5] The latter investigator found by adding 1% of nickel to grey cast iron that graphite was increased from 2·54 to 2·77%, and that there was a slight increase in strength, but decrease in hardness. Smalley's[6] grain-refining experiments indicated that nickel to the extent of 0·5% had a densing effect on the structure, but that the hardness was unaffected. Piwowarsky[7] confirmed the graphitising influence of nickel, and also showed that a moderate nickel content, 0·5 to 1%, improved the mechanical properties of grey cast iron by 20 to 30%, but with a higher content up to 2% a falling-off took place owing to too favourable graphitisation.

In America a considerable amount of work has been done. Merica[8] found that nickel increased graphitisation, 1% nickel producing a similar effect to 0·25 to 1% silicon. The use of nickel produced maximum hardness and fine grain, and gave castings which were readily machinable. A comprehensive investigation by Wickenden and Vanick[9] on the influence of nickel and nickel-chromium additions to cast iron gave results of considerable commercial value. In the experiments with nickel alone, this element was varied from *nil* to 5% in three grades of iron, containing 1·4, 2·0, and 2·7% of silicon respectively, and having low sulphur and phosphorus contents, and found to have a marked effect in accelerating graphitisation and carbon decomposition. It was also very effective in reducing chill and in refining the grain of the iron, whereas larger additions of nickel, 5 to 10%, coarsened the grain. Nickel addition of 0·25 to 5% increased the hardness without impairing the machinability. A recent American paper by Houston[10] indicates the proper balance of elements in grey cast iron containing nickel. The approximate equivalents are given as one part carbon equals six parts nickel, and one part silicon equals two parts nickel in reducing chill.

Recent systematic work in Britain by Everest, Turner, and Hanson[11] have produced results of a somewhat similar nature, results which are supported by a large amount of experimental evidence, and are of practical use. In order to obtain the best results, it is clearly shown that the basis of nickel cast iron is in the use of suitable composition iron having a normal carbon content, and with silicon content lowered to allow for the influence of nickel in producing graphitisation. Two or three parts of nickel appear to be equal to one part of silicon. With such a base iron the influence of nickel is to reduce chill, to increase hardness, to slightly improve strength without lowering the elasticity, and to increase the impact value. Machinable irons are obtained with a refined grain, and it is suggested that such irons will probably have better wearing qualities.

Chromium in Cast Iron.

The earliest work on the influence of chromium in grey cast iron is probably that of Keep,[1] who added this element up to 2%, and found a slight increase in strength up to 1%, then a decrease. In a later investigation, Campion[5] showed that 1% of chromium increased the strength and hardness, and also the combined carbon content, while Hurst[12] found that 0·9% chromium, with 1% silicon, gave a mottled iron and 4% chromium a white iron, which drastic annealing at 950° C. failed to decompose. Small additions of chromium of 0·11 and 0·15% to ordinary cast iron and cylinder iron by Smalley,[6] increased the strength and hardness of the irons slightly, while a larger addition of 0·78% produced an increase in the transverse strength and hardness of both irons.

Experiments by Piwowarsky[7] indicated that with up to 0·5% of chromium the strength, hardness, and shock-resisting properties of cast iron are increased, and similar results were also obtained by Hamasumi[13] with 0·4% chromium. In the economic aspect of chromium additions to cast iron dealt with by Houston[10] it is stated that one part of carbon is equal to three parts of chromium in reducing chills, and one part of silicon neutralises one part of chromium. Hanson[14] considers that the most prominent influence of chromium is its stabilising effect on the combined carbon. It has also, however, a refining and hardening action on the pearlite of the iron, and in this respect it is similar to, but rather more powerful than, nickel.

The author,[15] in an investigation on the influence of chromium in cast iron, found that adding chromium to grey cast iron in quantities up to 0·9% produced an increase in the stability of the combined carbon at temperatures up to 550° C., and that this increase was probably due to the chromium carbide present in the cementite of the pearlite. The increased stability of the carbide was shown in the increased strength obtained both at ordinary and elevated temperatures—temperatures up to 600° C.—and in the increase in Brinell hardness, with the result that better heat-resisting irons are obtained. There is difficulty, however, in machining irons with over 0·4% chromium, in the presence of 1·5% silicon. As regards the influence

of chromium on volume changes, these were found to be erratic at temperatures below the critical range, but the general effect was to produce a contraction.

In view of the many advantages gained in steel in reducing corrosion by chromium additions, the author subjected various chromium iron to a series of corrosion tests, and found that small additions of chromium reduce very slightly the corrosion of grey cast iron. The influence is most marked with sea water, and to a lesser degree with strong acids. There is little advantage gained with weak acid, tap water, or ammonium chloride. These results are somewhat similar to the results obtained by Kotzschke and Piwowarsky,[16] who found that chromium up to 1% increased the resistance of cast iron to acids, but with castings subjected to the rusting influence of salt solutions practically no advantage was gained. It would appear, therefore, as if chromium would have to be present in quantities larger than 1% to produce any marked influence on the corroson-resisting properties of cast iron.

Nickel and Chromium in Cast Iron.

Although, as has been stated, nickel and chromium have a similar effect on the pearlite of cast iron as on the pearlite of steel, in refining and hardening, the two elements have opposite effects on other properties. Nickel produces graphitisation, and reduces chill, whereas chromium increases the stability of the iron carbide and accentuates chill. At certain temperatures also nickel reduces the heat resistance of cast iron and promotes growth, while chromium increases the heat resistance at all temperatures and reduces volume changes. The alloying of both elements in cast iron, with a view to obtaining the beneficial influences of both, and the using of the one element to counteract the adverse influence of the other has been the object of a number of experiments.

Wickenden and Vanick[9] showed that to increase the strength of cast iron requires different amounts and ratios of nickel and chromium for different compositions of iron and for different sections of castings. To increase the strength from 10 to 15% required 0·5 to 1·0% nickel, together with 0 to 0·5% of chromium, depending on the silicon content—high silicon requiring a larger addition of chromium. Somewhat similar ratios have been indicated by Houston,[10] and have already been dealt with, while Hanson[14] states that for chromium additions up to 0·4% nickel may be added to contract chromium in the ratio of three or four parts to one, the ratios being varied slightly with the class of iron used and the nickel chromium ratio with the amount of chromium added. Heat-treatment experiments on nickel-chromium cast irons carried out by the author[17] indicated that these irons had good heat-resisting properties. When compared with plain irons, the carbide showed increased stability at temperatures up to 550° C., the strength at elevated temperatures up to 600° C. was maintained, and volume changes up to 550° C. were practically *nil*.

The practical applications of nickel-chromium grey cast irons are varied. They can be used with considerable advantage in the manufacture of Diesel engine liners and automobile cylinders, where uniform hardness is required, and where irons have to be highly resistant to heat. They are also of use in pressure work, and with higher percentages of chromium up to 1% for the manufacture of cast-iron rolls, where very hard white irons are required. In all cases, however, it is necessary to use a good base iron of suitable composition, and to add the alloying elements in the most suitable proportions, so as to obtain the best results possible from each element. Only by doing so will the irons be of an economic value and justify the additional use of nickel and chromium.

Other Elements in Cast Iron.

Elements other than nickel and chromium have been added to cast iron by various investigators, and interesting results have been obtained, but there has been little practical application of these results, due principally to cost and to the difficulty of alloying. Tungsten in proportions up to 1·5% increases the strength, both tensile, transverse, and compressive, without materially affecting the grain of the iron. Somewhat similar results are produced by molybdenum up to 0·5%. The influence of both elements appears to be similar to that of chromium in stabilising the combined carbon, although not nearly so marked, and this stabilisation is reflected in the heat-resisting properties. Vanadium in small quantity up to 0·25% has also a beneficial effect on the strength properties, but tends to produce graphitisation on heat-treatment. Experiments have also been carried out with additions of tin, aluminium, copper, and titanium, but the results obtained have not shown that additions of these elements are of practical value to cast iron.

1 W. J. Keep, "Cast Iron," 1916; p. 212.
2 L. Guillet, "Comptes Rendus," 1907; vol. 145, p. 552.
3 H. Thaler, "Jour. Iron and Steel Inst.," 1912; vol. 2, p. 583.
4 W. Hatfield, "Cast Iron in Light of Recent Research," p. 100.
5 A. Campion, "Foundry Trade Journal," 1918; vol. 20, p. 467.
6 O. Smalley, "Proc. Inst. Brit. Foundrymen," 1922-23; vol. 16, p. 495.
7 E. Piwowarsky, "Foundry Trade Journal," 1925; vol. 31, pp. 331 and 345.
8 P. D. Merica, "Iron and Steel Canada," 1925; vol. 8, p. 86.
9 T. H. Wickenden and J. S. Vanick, "American Found. Assoc.," 1925; vol. 33, p. 347.
10 D. M. Houston, "Trans. Amer. Soc. for Steel Treating," 1928; vol. 13, p. 105.
11 A. B. Everest, T. H. Turner, and D. Hanson, "Jour. Iron and Steel Inst.," 1927; vol. 2, p. 185.
12 J. E. Hurst, "Metallurgy of Cast Iron," p. 139.
13 H. Hamasumi, "Foundry Trade Journal," 1925; vol. 32, p. 71.
14 D. Hanson, "Metallurgist," 1929; vol. 5, pp. 38 and 56.
15 J. W. Donaldson, "Foundry Trade Journal," 1929; vol. 40, p. 489.
16 P. Kotzschke and E. Piwowarsky, "Arch. Eisenhüttenwes.," 1928-29; vol 2, p. 333.
17 J. W. Donaldson, "Proc. Inst. Brit. Foundrymen," 1924-25; vol. 18, p. 89.

THE MODERN BLAST FURNACE.

(*Continued from page* 100.)

fuel economy in most cases. When the limit of temperature which the stove refractories will safely stand has been attained, then only does the use of dried blast appear to be the next logical step. According to Lewis, the Silica Gel plant at Wishaw was installed because it was felt that the blast temperatures used (1,450° to 1,500° F.) were the highest that could be maintained without endangering the stove refractories.

At the same time, the more accurate control of the furnace operations associated with the use of blast of constant moisture content is a great advantage. On many furnaces making low-silicon irons, much fuel is expended at times, and much off-grade iron made, in keeping the bogey of a cold stick-up at a safe distance. The narrowing of this necessary margin by the elimination of a troublesome variable is not the least of the advantages of the use of dried blast.

It might be suggested that changes in the moisture content of the blast, as shown by frequent hygrometer readings, could be compensated in a thermal sense by *pro rata* alterations in blast temperature. From the operator's point of view, such a practice would be much inferior to the use of blast of uniform moisture content and constant temperature. Uniformity of as many factors as possible should always be the aim in blast-furnace practice.

(*To be continued.*)

Barrow Haematite Reconstruct.

The Barrow Haematite Steel Co., which owns iron and steel works and iron-ore mines and limestone quarries at Barrow and a colliery near Barnsley, is the latest of the iron and steel companies to draw up a scheme of capital reduction and rearrangement. In 1928 the company was compelled to ask the First Debenture Stockholders to grant a one-year moratorium. This was extended for a further year in order to give the directors time in which to draw up a scheme of reconstruction. As was to be expected, the scheme is a drastic one. The Debenture stockholders will take over the control of the company, but they are asked to consent to a prior lien issue of notes. The First Debenture stock, amounting to £780,393, is reduced to £390,197, and will in future carry interest at 6% instead of 5%, tax free, but during the first three years this will only be payable if the necessary profits are earned. Holders will receive £50 of stock and £75 in fully-paid Ordinary shares of £1 each for every £100 of stock now held; for every £20 of unpaid interest to June 30, 1930, holders will receive one fully-paid Ordinary share of £1.

The Coreless Induction Furnace

By A. G. Robiette, B.Sc. (Met.).

(Of Electric Furnace Co., Ltd.)

IT was thought at first that the advent of the arc furnace would sound the death-knell of the old time-honoured crucible process. This prophecy, however, did not fully materialise, and although it limited considerably its scope it did not entirely supplant Huntman's crucible process for many purposes. It was held that the intense heat of the arc, which is responsible for the outstanding success of the arc furnace as a refining appliance and for its merits in the rapid melting of alloy-steel scrap, was a disadvantage for the melting of plain-carbon crucible steels. In recent years, however, the crucible process has been revived in a different and much more attractive form, and it is with this novel type of furnace, known variously as the high-frequency, ironless, or coreless induction furnace, that this contribution proposes to deal. Its outward characteristics, both metallurgical and electrical, are now too well known and too ably described elsewhere* to merit repetition here; but there are some features of its design and operation not so well understood, and which assume considerable importance in the light of recent developments that deserve attention.

It is essentially a crucible furnace, and it is the return to this familiar and convenient shape of bath which is the distinguishing feature of this furnace, as contrasted with other so-called low-frequency induction furnaces. This obviated the necessity for leaving a quantity of molten metal in the channel with which to start the next charge, and it thus rendered induction melting flexible to mixture changes. Moreover, no continuous application of power is necessary to prevent the lining cracking on restarting, and standby charges are thereby eliminated.

The earlier furnaces were of small capacity, and high-frequency currents were needed as the electro-magnetic "coupling" between the charge and the inductor coil is too small to produce sufficient heat to melt the charge. The original Ajax-Northrup furnace was therefore supplied with high-frequency current of the order of 20,000 cycles per second by an oscillating discharge from a bank of condensers through a spark gap. The capacity of this type of furnace is limited, and expansion beyond 60 k.w. does not seem easy or convenient, even with the use of rotary (and noisy) spark gaps. These latter are also too frail for the heavy duty of works conditions, and even if a suitable spark gap could be designed, it would be very inefficient as a spark oscillator converts only a fraction of the input energy (approximately 40%) into high-frequency energy. This type of furnace has, however, done good and invaluable work as a laboratory tool for research work, and for the melting of refractory and precious metals, such as platinum, iridium, and gold. Fig. 1 illustrates a 35-k.v.a. furnace of this type with a mercury spark-gap converter.

For larger industrial units (melting 300 lb. per hour and upwards) high-frequency current becomes no longer necessary or desirable, and frequencies low enough to be readily generated by rotary machines become practicable. When frequencies are thus reduced the term "high-frequency furnace" becomes misleading. Neither can the furnace be designated as "the ironless induction furnace," as in some recent designs an iron yoke linking a part of the outer magnetic circuit has been used. Northrup has suggested the term "coreless induction furnace," which

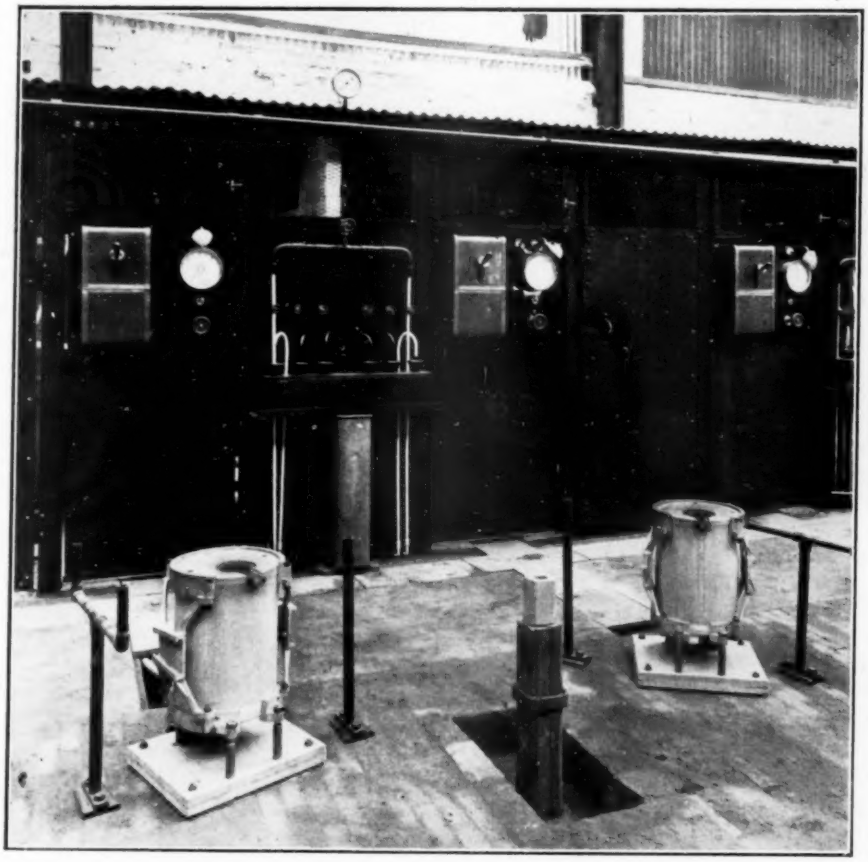


Fig. 1. Two 35 k.v.a. Coreless Induction Furnaces used for melting "Mumetal."

* D. F. Campbell, J.I.S.I., 1925, No. 2, J.I.S.I., 1927, No. 2; J.I. Metals, 1927, No. 1.

seems an improvement in view of recent developments. With a steadily increasing demand for this form of melting equipment, and with the standardising of designs, the first cost of the motor-generator installation is being reduced. In some instances the drawback of the initial outlay is partly overcome by working a battery of furnaces from a single large motor generator. This arrangement, although gaining something by the higher efficiency of a single generator over several small units, has the great disadvantage that a shut-down of the generator immobilises the whole plant. A 650-k.w. motor generator set for operating a 1-ton coreless induction furnace is illustrated in Fig. 2.

With regard to the design of the furnace, it is no longer possible to base calculations on known resistance data from the geometrical shape of the secondary, as this latter is not now in the shape of a definite closed channel. A peculiar phenomenon is introduced in that the current does not traverse the whole of the secondary but only penetrates to a certain depth, and on account of this it is possible to obtain a correspondingly high electrical resistance. According to Steinmetz, the depth of penetration depends on the electrical resistance of the material, the permeability, and the periodicity of the current, and he has worked out the relation connecting these for rectilinear conductors. In the case of magnetic materials such as steel and nickel, there is a wide difference between the depth of penetration in the solid and liquid states since the magnetic properties alter as well as the resistance. It will readily be appreciated that very careful consideration must be given to these factors in order that the electrical characteristics of the furnace will be capable of giving a high electrical efficiency over a wide range of metals, which is often the case in certain non-ferrous works where the equipments are called upon to melt widely differing metals such as copper, cupro-nickel, high-copper alloys, and often pure nickel.

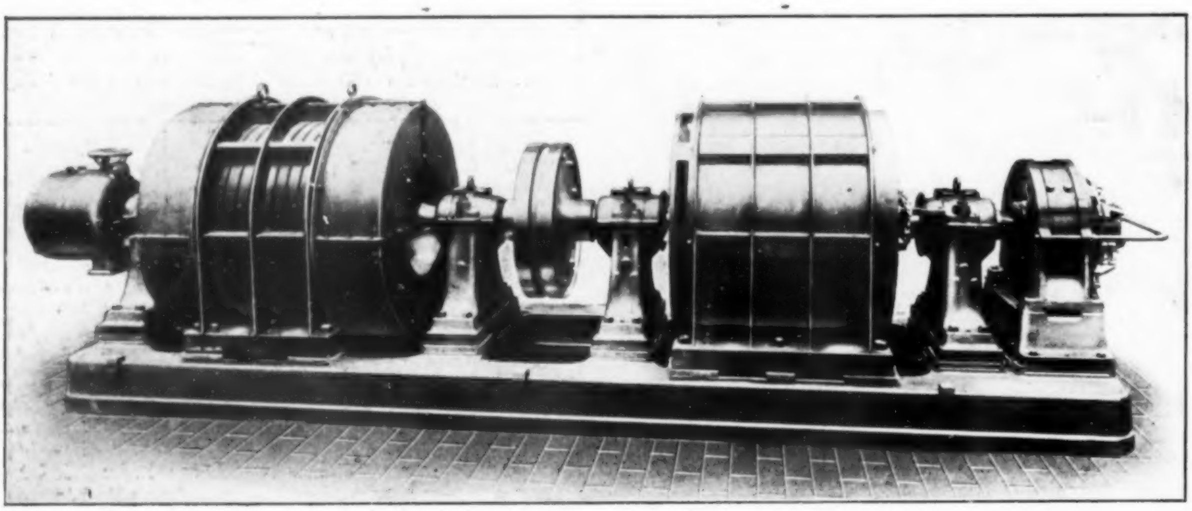


Fig. 2. 650 k.v.a. Motor Generator set for operating a 1-ton Coreless Induction Furnace.

The peculiar phenomenon noted above, and known as "skin" effect, must also be considered in the primary coil. From Steinmetz's formula the depth of penetration increases as the resistance increases, so that when the coil gets hot the current penetrates to a greater depth and allows of a comparatively high current density without overheating the primary coil.

The furnace will naturally present a highly inductive load (the power factor being of the order of 0·1), and to compensate for the large wattless current a bank of oil-immersed paper-insulated condensers is used. This is a very important part of the plant, and at the outset considerable difficulty was experienced in obtaining reliable condensers at a price which would not detrimentally affect the economics of the process. The trouble experienced was the removal of the heat in the dielectric. This difficulty has now been surmounted, and to render them less sensitive to temperature changes they are water-cooled and situated in a well-ventilated bank.

This bank is divided into two units, one being permanently in circuit, while the other is controlled by contactor or sector switches, so that the power factor can be kept at unity throughout the varying conditions of the heat. The operation of the furnace, however, calls for no degree of electrical skill. An ammeter is placed in the coil circuit and another ammeter in the condenser circuit, and all the operator has to do is to keep the needles of these instruments pointing to the same figure (this may also be done with a single instrument) by putting in or cutting out condensers from the circuit, and to control the input by means of a field rheostat.

Just as in the case of the arc-furnace, automatic control can be applied. In place of the raising and lowering of the electrodes the condensers are switched in and out, as the case may be, so that the power factor is automatically kept at unity. For a single unit it is doubtful whether the extra cost of this equipment is justified, but when a battery of furnaces is installed it is worth consideration. From the point of view of the power supply company the furnace presents an excellent load, there being no surges or voltage fluctuations as in the case of the arc furnace, and the overall power factor is maintained approximately at unity throughout, while on the other hand in the arc furnace the introduction of a reactance to damp these surges will lower the power factor somewhat.

With regard to the choice of the most suitable frequency, this will depend on economic as well as technical requirements.

As explained before, the penetration is governed by the frequency for any particular metal, so that for large furnaces a lower frequency must be used. It will also depend on the specific resistance of the metal to be melted, but the ruling factor is the size of the furnace. For a given size of furnace if the frequency is low the turns in the inductor coil will be high, and the I^2R losses correspondingly great. Thus, by using a higher frequency (other things being equal) a more efficient furnace is obtained. The capacity of the condenser circuit varies inversely as the frequency, so that if the frequency is doubled the cost of the condenser plant is halved; on the other hand the generator will become more costly as the frequency rises, so that a compromise has to be reached.

For a 5-cwt. furnace a frequency of about 2,200 cycles is most suitable, while for a 1-ton furnace a considerably

lower frequency is employed (around 900 to 1,000 cycles). It is interesting to note that coreless induction furnaces have been built working from supplies of normal periodicity (50 cycles), and they have found application in non-ferrous works where alloys of widely differing compositions have to be melted. This, however, is not standard practice, and the time is not yet ripe for a discussion of the economic advantages or otherwise of the procedure.

The whirling motion of the charge in a vertical plane, due to electrical forces, which is so beneficial for the thorough mixing of alloys (especially those consisting of metals of such dissimilar densities as iron and tungsten), is also a function of the frequency. The lower the frequency (other things such as power input being equal) the greater the stirring action. In the case of the 50-cycle furnace the rotatory motion is so vigorous that the charge almost assumes a spherical form, the molten metal hardly making contact with the sides of the crucible or lining. With regard to the voltage, this will be governed largely by the size of the furnace and the frequency. The cost of the condensers, however, which form a considerable item in the initial outlay, is reduced as the voltage rises, so that generally the highest permissible voltage is used.

Another feature of this system of heating, which is too often lost sight of, is the almost unlimited speed of melting. Here the energy passes to the charge by way of the "ether," which has a seemingly limitless capacity for the transmission of energy. In all other systems of heating the rate of transmission depends almost wholly on the temperature gradient, and to promote very rapid heat transfer impossibly steep temperature gradients would have to be used. Even with induction furnaces having a closed channel the speed of melting is restricted by electrical forces such as the "pinch" effect, and in a furnace with a submerged channel, like the Ajax-Wyatt furnace, excessive overheating of the metal in the slot with rapid erosion of the refractory lining would result.

There are many obvious advantages of rapid melting, not the least of which is the minimising of radiation and conduction losses, and at the same time reducing oxidation and subsequent "killing" additions.

The advantages of extending this principle to heat-treatment problems may also be visualised, and it is possible that our present notions of annealing times for the removal of stresses and the reconstruction of the deformed crystal grains may be completely upset, as in this case the temperature gradient is from the inside outwards. Extremely high rates of heating (especially as the heating is uniform throughout the body of the charge, and high surface temperatures are not required as in heating by temperature gradients) might prove beneficial to the solution of some of our more important annealing problems.

The power consumption in the coreless induction furnace compares very favourably with that obtained in the arc furnace, recent improvements, and especially the successful adoption of larger-sized units, having reduced the power consumption to well below that for a normal arc furnace. On a recently installed ½-ton Ajax-Northrup furnace an average consumption over 10 consecutive heats of 570 units per ton was recorded when melting high-speed tool steel in 50 to 55 minutes per charge. For plain carbon and other alloy steels the consumption averages about 650 units per ton. It is interesting to note this lower consumption, which always prevails in the melting of high-speed tool steels (16 to 20% tungsten) in this process. It is probably connected partly with this fact that tungsten considerably raises the A2 or magnetic transformation point in steel and also lowers the heat content of high-tungsten steels.

It will be generally admitted that one of the most vital parts of a furnace from the user's standpoint is the refractory lining, and it is in this direction that many of the latest improvements have been effected.

Formerly, costly crucibles of clay or plumbago supported by a heat-insulating packing of sand or zirconia were employed. These, however, had a short life and an uncertain performance. A recent development, due to Rohn (British Patent, No. 226801), has enabled an average life of about 60 heats to be obtained in a single lining—a result whose importance may be gauged if it is realised that plumbago crucibles gave an average life of 16—18 heats, while the clay pots with careful handling lasted 6—8 heats. The method consists in rapidly fritting a dry, granular, refractory material specially prepared with a dry binding substance by means of a metallic template or former, which is raised to a white heat by induction. This former may be cast or made of the same metal as the proposed charge, and the dry refractory cement is poured and rammed into the space between this former and the electrically insulating sleeve of mica and/or asbestos which surrounds the coil. When the current is switched on this metallic former is gradually raised to a white heat which frits the cement, the former being subsequently melted and incorporated in the first charge. This lining, which is generally about 1½ in. to 2 in. thick, is only fritted to a certain depth, giving a very hard, strong surface which will withstand a great deal

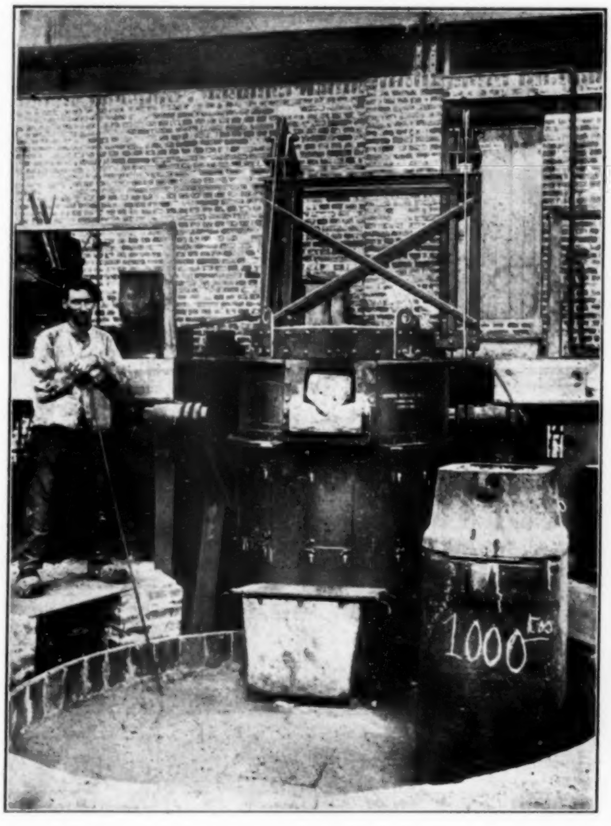


Fig 3.

of abuse, while the backing is composed of loose, unfritted cement which serves as a heat insulator. It will also be realised that crucibles above ¼ ton of steel capacity would be difficult and expensive to manufacture, and it is very doubtful whether reliable crucibles could be made with a capacity exceeding 600 lb. of steel. The Rohn fritting process, therefore, by making larger furnaces possible has materially aided the development of the coreless induction furnace. Fig. 4 shows a section of a furnace lined by this method.

The successful development of basic linings by this method has opened up new fields of possibility hitherto unexplorable with siliceous linings. They seem a distinct improvement for the melting of certain alloys, such as nickel-chromium and nickel-chromium-iron alloys, as the oxides, or rather a combination of the oxides, of these metals have a particularly destructive effect on most acid

linings. These basic linings are also less susceptible to rapid temperature changes, with resultant cracking, than siliceous ones.

The convenient shape of the bath in this furnace makes refining operations more practicable than in furnaces with complicated secondary channels, and the application of an auxiliary source of heat (such as an arc) to enable certain slag reactions to be completed becomes more feasible. Moreover, the slag is kept hot enough for most reactions by the vigorous and continuous stirring action in a vertical plane bringing each particle of the metal successively in contact with the slag. The significance of this rotatory movement in the hastening of chemical reactions is evidenced by the fact that practically no "killing" time is required as in the crucible process, deoxidation being almost instantaneous on the addition of the finishing materials. In the common refining processes the rate of attainment of chemical equilibrium (when this is needed), or, more generally, the rate of chemical reactions, depends on the natural rate of diffusion, and also on convection currents resulting from changes of density of the bath. For example, when a light element like silicon or phosphorus is eliminated the heavy desiliconised metal will sink, giving place to

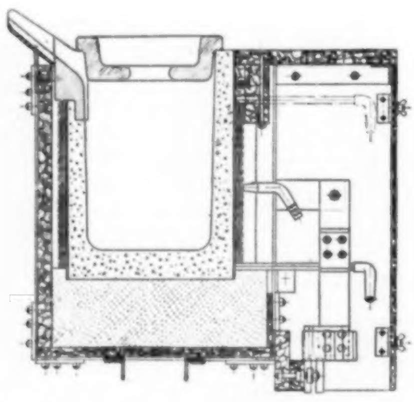


Fig. 4. Section of a Coreless Induction Furnace lined by the Rohn Fritting Process.

metal richer in these elements. But the general practice is to resort to the agitation or "boiling" of the bath resulting from the elimination of carbon. This is not always convenient, and a rapid circulation from an external source would seem advantageous. It has been found that the elimination of the metalloids—carbon, silicon, and phosphorus—is only a matter of minutes in a coreless induction furnace.

It has also been recorded that very rapid decarburisation of ferro-chrome has been obtained by a method of air injection in this furnace, and that the removal of carbon takes place preferentially to the oxidation of the chromium —a result probably due to the reversal of affinities by maintaining a very high temperature. These experiments, however, were performed in a very small furnace, so that their practical significance is questionable.

It has been maintained that the rapid circulatory motion of the metal is a disadvantage for steel-refining operations and makes for a "dirty" steel, the swirling motion tending to intermix the slag with the metal. This is, however, disproved by the results of †Wever and Hindricks, and by general experience. On the other hand it is quite conceivable that, provided a fluid slag with a high surface tension is kept on the bath, the stirring action, by bringing each particle of steel into contact with the slag, will aid the separation of inclusions and so clarify steel.

† Archw. für das Eisenhuttenwesen I. No. 3. Nov., 1927.

It is doubtful, however, whether this refining process supplies of natural fuels as Scandinavia, Italy, and British Columbia, it might prove to be a competitor of the arc furnace, as it has done in this country in plain melting practice.

One interesting application of the convenience of this system of heating has been exploited by Rohn‡ with a view to eliminating shrinkage cavities or piping from nickel-alloy ingots. The cropping of ingots in normal steelworks practice is at the best only tolerable, but when dealing with expensive alloys which have a market value in the region of £400 per ton it becomes imperative to seek a remedy for this difficulty which is inherent in the methods at present in use. One method by which Rohn has attained the ideal solution to this problem is by allowing the metal to cool in a coreless induction furnace from the bottom upwards. The inductor coil is provided with a series of tappings, and the current is switched off from the bottom upwards, the current being increased in the upper turns, or a layer of insulating material placed on the surface to balance radiation losses from this source. From the nature of this process of solidification it would be expected that a very large grain structure would be obtained, but this has been very ingeniously surmounted by jolting or oscillating the furnace itself, and in this way interrupting the process of crystallisation.

The sudden burst into prominence of this system of electric heating has not enabled us properly to take stock of its potentialities, and there are many avenues of possibility still awaiting exploration, the results of which will doubtlessly be looked upon with interest by a metallurgical world fully alive to the advantages offered by this new set of physical conditions.

‡ J.I.M., 1929, No. 2.

British Standard Conversion Tables.

THE British Engineering Standards Association has recently issued comprehensive tables of conversions of inches to millimetres and millimetres to inches, covering both fractional and decimal subdivisions of an inch, and giving the conversions to the various degrees of accuracy mostly used in the classes of work coming within the scope of the Association.

The tables of inches and fractional sub-divisions of an inch give the conversions of every $\frac{1}{64}$ of an inch up to and including 12 in., whilst those for inch measurements in the decimal system give the conversions of every $\frac{1}{1000}$ of an inch up to 1 in. The table of conversions of millimetres to inches gives the conversion of every millimetre from 1 to 1000.

Included in the publication is a table giving conversion factors for linear, square, and cubic measures, weights, stresses, pressures, and weights per unit length for various measures common in engineering.

The greatest care has been taken to ensure accuracy in the published figures. They have been checked by the National Physical Laboratory, and the publication is printed from stereotype plates so that there may be no risk of errors resulting from displacement of type. It is felt, therefore, that the tables may be used with every confidence, and that they will provide a valuable addition to the reference books of every engineering office which has occasion to use the metric system of measurement in addition to the British.

Copies of these tables, No. 350, 1930, may be obtained from the Publications Department, British Engineering Standards Association, 28, Victoria Street, London, S.W. 1, price 2s. 2d. post free.

Some Notes on
Foundry Equipment and Appliances

It has become increasingly obvious that agreed methods of testing should be used by all investigators studying foundry moulding sands and new sands required in their preparation. It is with this object in view that the Council of the British Cast Iron Research Association has approved the general distribution of a report on "Methods of Testing Foundry Moulding Sands." The test methods that have been devised, and which are recommended for general adoption, are the result of much experimental work and consideration of methods which have been adopted or suggested by others. Every scientific test likely to yield information which would be of value to those requiring to use moulding sands in practice are fully detailed in this report. As a consequence of the tests outlined, the authors, Messrs. J. G. A. Skerl and W. J. Rees, chose two simple tests for ordinary foundry control of moulding sand from day to day. These tests are described fully in this report and comprise compression strength and permeability tests. The apparatus for permeability tests has been patented and is referred to elsewhere in this issue ; this apparatus, together with the apparatus for compression testing, may be purchased at very moderate cost. In each instance, the apparatus is simple and robust to allow of its use in a foundry or works laboratory. In the permeability test the depth of core corresponds to the depth of an average moulding box, and the cylinder in which it is made can be readily fixed for use on a jolter. Thus, a core can be rammed similar to the sand used in practice and the results found on test have an immediate value. All interested in methods of testing moulding sands should have this report which is obtainable from the British Cast Iron Research Association, 24, St. Paul's Square, Birmingham, at a net price of 10s. 6d.

Mixing and Conditioning Sand.

The need of labour-saving plant and appliances is no more apparent than in dealing with sand. A combined sifting, separating, handling, and conditioning plant, such as is illustrated in Fig. 1, has much to recommend it. This represents one of many types supplied by the Rapid Magnetting Machine Co. It is designed to reduce to a minimum handling of the sand, an elevator being integral with the plant, to raise the sand from the floor level to be separated, reconditioned, and delivered over a shaker ready for use. It is a continuous operating plant and the maintenance costs are low.

A variation from general practice in conditioning sand is effected in the Pneulec "Royer" machine by means of a canvas and rubber belt which carries steel teeth. The belt moves at a high speed of 900 ft. per minute, and the teeth have a peculiar combing action upon the sand supplied to it giving that degree of blending desirable. The belt is not encased and its operation cannot be congested by accumulated sand or scrap. Due to the speed at which the belt travels, the pockets formed by the teeth are not fully loaded until the full length of the hopper has been travelled, when the sand is thrown forward through a special type of steel comb. This machine, which is readily transported where required, is shown in operation in Fig. 2. In this case the fully conditioned sand is shown being thrown into a moulding box as fast as the machine can be fed.

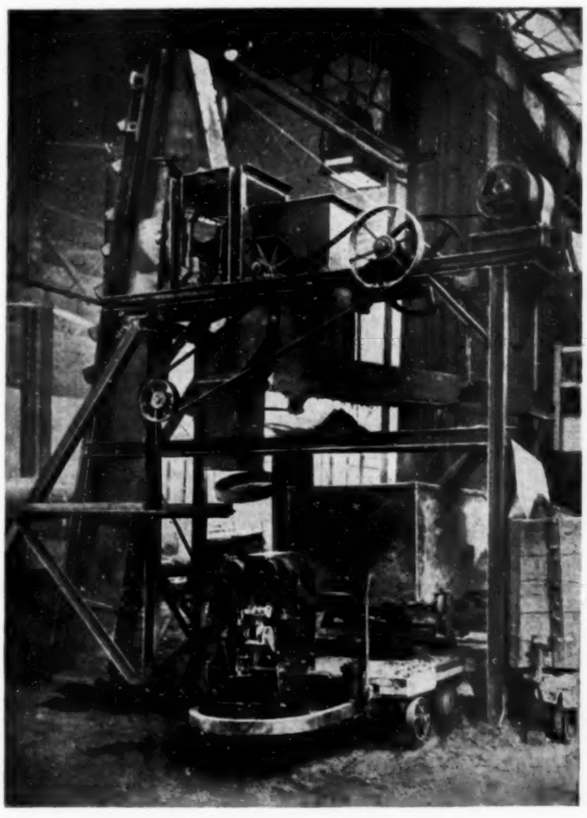


Fig. 1.—"Rapid" Sand Plant recently supplied to a Scunthorpe Foundry.

Core Sands.

The use of oil as an artificial bond for core sands is not now an experiment as it has long since proved its value. One of the difficulties associated with oil sand cores is the relatively low green strength which adds to the cost of their production. To counteract this difficulty a grade of Spermolin core oil is now obtainable which possesses all the advantages for bonding purposes, but also gives to sand cores that green strength corresponding to cores made from ordinary naturally bonded sand. There are many grades available to suit varying classes of work.

It has long been recognised that adequate mixing of core oil and sand cannot be accomplished by hand ; there is difficulty in obtaining that degree of regularity. Many mechanical oil sand mixers are now available. A very efficient form is that shown in Fig. 3, in which the sand is rotated and conveyed to the centre of a container by left- and right-handed scrolls, working on a common shaft. The action, which is continuous, causes a separation of the sand grains enabling an even distribution of oil without crushing the sand grains.

It may be mentioned that Spermolin, Ltd., are also the makers of a rotary core-making machine which is capable of producing vented round core at the rate of 240 ft. per hour. The construction is clean and simple, a special feature being a patent rising and falling tray carrier, which instantly adjusts the tray to the exact level and parallel with the die, thus eliminating the necessity for packing up the tray and obviating bent and distorted cores. The capacity is from ¼ in. to 3 in. diameter for round cores, but cores of any regular section—such as square, oblong, oval, and hexagon—can readily be made.

Moulding Machines.

It is customary to associate moulding machines with

repetition foundries for which purpose there is available a wide range of machines designed to cope with work between definite limits. Keener competition is directing attention to the use of machines for more general work, and a considerable impetus would be given to their use if some methods were devised for reducing time and cost of pattern plates. The plain jolter has many advantages for ramming moulds, relieving the moulder of the more laborious work. This is an effective machine for general work and, providing adequate transport facilities are available, one machine would serve many moulders. The Sandslinger is another machine particularly adapted to general as well as repetition work, but it is essential to give it as wide a range as circumstances will permit in order to keep it fully employed and make it an economical proposition. Every effort should be made to reduce manual labour to bring the foundry in line with modern progress. Foundries, whether dealing with general or repetition work are well served by hand and power operated machines, of the latter a very popular type is the jolt-ram machine similar to the improved "Peacolt" machine shown in Fig. 4. These machines have a wide range of usefulness, giving them a high degree of adaptability, which is one of their chief advantages. They are fitted with oil control, to facilitate the steady drawing of the pattern, and a turnover device, giving every convenience for rapid production.

Fig. 2. The "Royer" Portable Machine for Conditioning Sand.

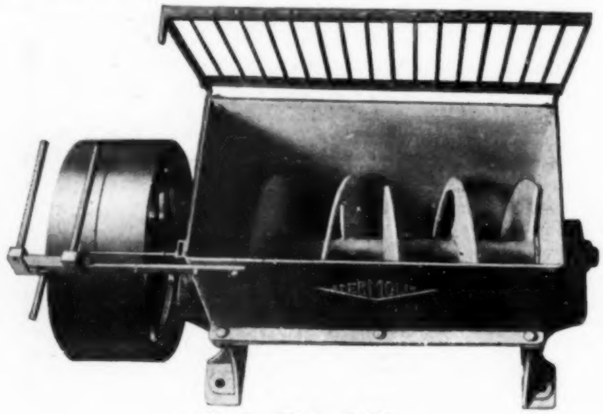


Fig. 3. Oil Sand Mixer.

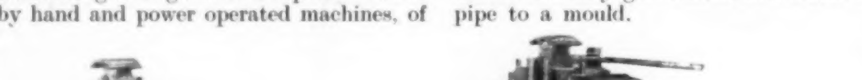


Fig. 4. Power Operated Jolt-Ram Machine.

Ovens and Portable Driers.

The primitive methods of mould and core drying by means of open coke fires and braziers are gradually being superseded by the application of hot dry air which extracts the moisture and discharges it before any condensation can take place. The old method of drying by the application of direct heat, from one or two sources, gives irregular temperature, which not only creates difficulties with the moulds and cores, due to unequal drying, but is a wasteful and uneconomical method. In the August system of core and mould drying advantage is taken of the fact that air has the capacity of absorbing water vapour and holding it in suspension. It is on this principle that their ovens are designed, the temperature of the air passing through them being raised to increase its capacity for carrying water vapour in suspension. This method gives a more regular temperature which effectively dries the work without burning parts. The stoves are built with the hot air generating chambers adjacent to them and a connection is made by underground flues. The stove doors are usually insulated to conserve the heat. The portable mould drier is particularly useful for work to be dried on the foundry floor. In these driers air is passed over an incandescent bed of ordinary gas coke and directed through a delivery pipe to a mould.

Melting Furnaces.

Two non-ferrous melting furnaces recently designed are now being manufactured by Messrs. Armstrong Whitworth. One is an open flame non-crucible semi-rotary type suitable for melting brass or bronze. In addition to saving, as a result of melting the metal directly in contact with the lining of the furnace, it is economical in operation, 1000 lb. of scrap brass having been melted with the remarkably low oil consumption of 5 gals. Average consumption of oil used in this furnace for melting during a period of one week worked out at 0.9 of a gallon per 100 lb. of metal melted. This furnace, which is illustrated in Fig. 5, is fitted with two burners, the flames from which are directed to the centre

of the furnace, producing a reverberating incandescent heat favourable to rapid melting and low consumption of fuel. The other furnace illustrated in Fig. 6 is a tilting furnace specially designed for melting aluminium. It is

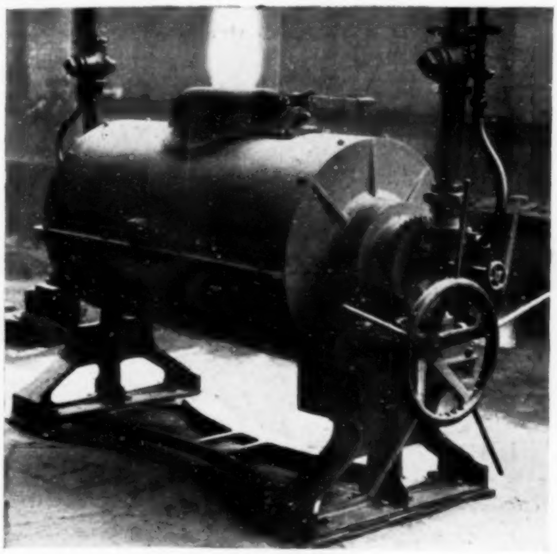


Fig. 5. Non-ferrous Rotary Furnace.

designed on the central-axis principle, and is fitted with a special iron crucible which is supported on a heavy split flange on top of the furnace body. This heavy cast flange enables the crucibles to be cast with a minimum weight of

Fig. 7. Pyrometer for Chills and Metal Moulds.

flange. Spaces in the split ring allow waste heat and spent gases to pass into the upper melting chamber, thus minimising oxidation and also utilising what would otherwise be waste heat. This type of furnace, when fitted for

Fig. 6. Tilting Furnace for Aluminium.

gas firing, has two burners arranged to fire tangentially around the crucible to eliminate direct impingement of the flame on the crucible. The capacity of this furnace is 600/1000 lb., and, in use, it averages 70,000 lb. of aluminium for each crucible, which indicates low maintenance costs.

Pyrometers.

The pyrometer plays an important and indispensable part in melting and casting metals and alloys, and also in preparatory processes, such as core drying, and after-processes, such as annealing, hardening, etc. For temperatures of molten metals in which the temperatures do not exceed 1,400° C., the thermo-couple method may be employed. When the temperatures to be measured exceed 1,400° C. the useful life of a thermo-couple becomes too short to render its use an economic proposition. In such cases the disappearing filament pyrometer is a simple, inexpensive, and self-contained instrument for measuring temperatures up to 2,100° C. When greater accuracy is desired an optical pyrometer may be used. This instrument gives direct readings of temperatures between 700° C. and 4,000° C., it is a practical and convenient means of measuring accurately and can be successfully used by unskilled workmen. It may be regarded as a photometer in which rays from the molten metal or other hot body are compared with a light of known intensity. An eye-piece is rotated until the two lights appear to the observer to be of equal intensity and the temperature is then read directly on a calibrated scale. It is a product of the Cambridge Instrument Co., and a National Physical Laboratory certificate of accuracy is furnished with each instrument.

A useful form of pyrometer has recently been developed by the same company for measuring the surface temperatures of chills and metal moulds. The thermo-couple is of a novel design, being in the form of a thin and comparatively wide strip of metal, which, when applied to a heated surface

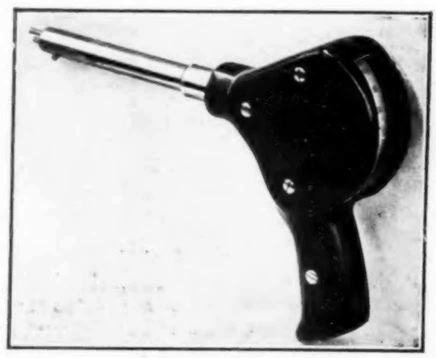


Fig. 7. Surface Pyrometer for Non-ferrous Metals.

takes up its temperature almost instantaneously. Various patterns of these surface pyrometers have recently been introduced for different applications, in the majority of which the strip form of thermo-couple is employed. In the pattern illustrated in Fig. 7, the thermo-couple strip is made in the form of a small, elongated loop, at the centre of which is the thermo-junction. The thermo-couple holder is pivoted to the end of a hollow metal rod which facilitates the application of the thermo-couple to surfaces which are not easily accessible. The wires from the ends of the thermo-couple strip pass down the inside of the hollow metal rod and are connected by a short length of flexible steel armoured lead to a portable indicator, calibrated to read directly in degrees of temperature. A somewhat different type of surface pyrometer, shown in Fig. 8, is designed for taking the temperatures of non-ferrous metals. In this in trument the thermo-couple comprises two sharp metal prongs embodying the wires forming the elements and protruding from a cylindrical barrel, the actual thermo-junction completed by the surface of the metal against which the prongs are pressed. The indicator is embodied in the handle of the instrument on the rear end of the thermo-couple, the complete instrument having the shape of a revolver.

The scale is arranged edgewise at the back of the instrument with the figures upright, so that it is directly in the line of sight when the thermo-couple is applied to the surface and can be read at a glance.

Cleaning and Fettling.

Several important improvements have recently been made in the design of sand-blast equipment, particularly in regard to the apparatus for the suppression of dust during the process of sand blasting. A notable instance is the sand-blast apparatus manufactured by Tilghman Company, shown in Fig. 9, and now supplied as standard equipment. This apparatus provides for the abrasive material being definitely separated from the dust which is created and also from the moulding sand, scale, etc., and returned to the appliance in a clean condition for re-use, the whole operation being performed by one exhauster that is necessary to clear the chamber or sand-blast machine.

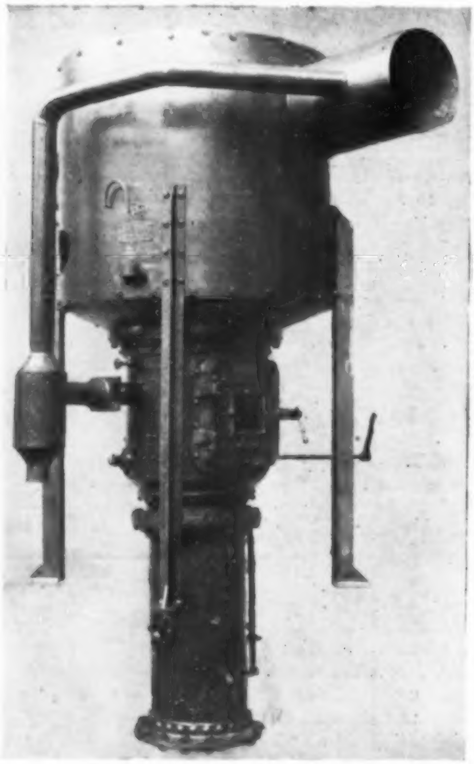


Fig. 9.

An arrangement is provided by which a current of air is passed through the curtain of shot and dust as it falls, by gravity from the settling chamber, to the pressure chamber. The draught, being adjustable, can be varied to suit the weight of abrasive, and also the degree to which the separation is required. When only clean abrasive is allowed to pass to the blast, a larger area is covered on the articles under treatment, thus effecting a considerable saving in power.

The collection of the dust presents a problem which has now been satisfactorily solved by the Dust Arrester made by Messrs. Tilghman's Patent Sand Blast Co., Ltd. This apparatus, which is shown in Fig. 10, is fixed between the sand-blast machine and the exhauster, and removes all dust and grit before coming into contact with the blades of the exhauster, and is consequently superior in every way to a dust arrester which must be placed at the discharge side of the exhauster, as in this latter arrangement the blades of the exhauster wear rapidly.

Fig. 10.

Another feature is the provisionally patented blow-back system for clearing the screens of the accumulated dust. This is accomplished by means of damper valves fixed in the inlet and outlet pipes to reverse the flow of air through the screens. This arrangement has been found the most satisfactory method of clearing the fabric screens, particularly in the larger sizes, and is usually supplied as an extra.

A New Super High-speed Lathe.

A new high-speed lathe has recently been designed and constructed by John Holroyd and Co., Ltd., which possesses many unique and important features. It has been designed specially to take full advantage of modern high-speed cutting tools, such as tungsten carbide, etc. This lathe is capable of turning up to a maximum diameter of 20 in. with a maximum length of 11 ft. The height of centres is 15 in. and the lathe is electrically driven and controlled on the Ward-Lennard principle. The main 45 h.p. variable speed motor is directly coupled to the spindle with one pair of double helical oil-sprayed gears in the headstock. It is designed to give high speeds with a wide variation, recorded by tachometer, giving revolutions per minute of spindle and cutting speed in feet per minute for various diameters of work. The centralised push-button system on the saddle gives absolute control. In construction as well as design it gives that degree of rigidity which eliminates vibration. This factor is of primary importance to enable the maintenance of high cutting speeds, with the maximum removal of metal in the shortest time, without chatter.

It has been found impracticable to do heavy cutting with the work revolving on dead centres, as on an ordinary poppit, and ball-bearing running centres do not adequately get over the difficulty. By gripping the work in a chuck and revolving the loose head spindle, a solution to the problem has been found.

The tool cuts "upside down," similar to a back tool, which makes for smooth and steady cutting, and projects the turnings downwards to the rear of the machine. The bed and saddle have been designed to provide the correct resistance to twist and the direction of thrust, and there is every likelihood that this lathe will cover a wide field in coping with the higher speed of production which modern conditions demand.

Business Notes and News

The Blast-furnaces at Clarence Works to Cease Operation.

It is regrettable that the present intense depression in the iron and steel trade has compelled Messrs. Dorman, Long and Co. to take steps to close down the Clarence Works. With the exception of some few stoppages through minor trade disputes, these works have been in continuous operation since 1854. There are at present two blast-furnaces in operation at the Clarence Works—one producing haematite, and the other Cleveland iron. Both these are to cease working, and the output of pig iron in the district will be reduced by some 3,000 tons per week.

Sherburn House Colliery, from which these works draw considerable supplies of coal, will, in consequence of the stoppage of the works, close down on July 26.

The situation of the iron and steel industry is assuming a grave complexion. There has been a steady decline in output since the beginning of the year; this is clearly revealed by the statistics issued by the National Federation of Iron and Steel Manufacturers. In January the output of pig iron for the country was 650,000 tons; the reduction has been such that the June returns give a total output of 563,200 tons. The steel production, which in January amounted to 771,100 tons was last month reduced to 600,100 tons. The absence of confidence of both home and export trade is considerable, and, manufacturers are finding it very difficult to maintain plant in operation.

The closing of the Clarence Works is a most serious matter for the district, and will make a grave addition to the already growing number of unemployed and an increasing list of idle works. The coke-oven and by-products plants will, however, continue at work.

New Coke Plant.

An important development in the smelting of iron and steel is taking place at Messrs. Pease and Partners, Roddymore Colliery (County Durham), where work has just been commenced upon the construction of a new low-ash plant to deal with coke produced at the colliery by-product works. The plant will include the erection of a conveyer, elevators, coal crusher, and washing machinery, and will be the only one of its kind in the North of England.

This, it is anticipated, will have great advantages for smelting purposes, and the use of the coke produced by the new process for smelting will make for a considerable improvement in the quality of iron and steel.

The Morgan Crucible Co.

The registration of the Morgan Crucible Co, with a nominal capital of £3,258,000, is recorded. The company, it is stated, has been formed to acquire the undertaking and all or any of the assets, rights, powers, liabilities, and duties of the Morgan Crucible Co. Ltd. (incorporated in 1890) pursuant to a scheme of arrangement and reconstruction sanctioned by an Order of Court dated June 6, 1930, or otherwise as may be considered expedient. The capital is in £1 shares, 300,000 6% cumulative first preference, 300,000 5½% cumulative second preference, 500,000 7% non-cumulative preferred ordinary, and 2,158,000 deferred ordinary.

Chain-making Companies to Co-ordinate Interests.

A provisional agreement has been executed with a view to the co-ordination of the interests of the Coventry Chain Co., Ltd., and Hans Renold, Ltd. As soon as possible the full details of the scheme will be communicated to the shareholders.

Hans Renoid, Ltd., is a private company carrying on business at the Burnage Works, with a branch office in Yorkshire House, Cross Street, Manchester. Thd Coventry Chain Co. is associated with Brampton Bros., and its head office is at Spon End, Coventry. The share capital was increased from £110,000 to £150,000 in 1913, to £250,000 in 1915, to £500,000 in 1919, and to £715,000 in November, 1925.

Nile Delta Electricity Scheme.

Egypt offers unique possibilities to European firms. Its development is essentially modern, and electricity is the primary power factor in all its undertakings. Irrigation work, railways, roads, and the construction of ports form a large part of these undertakings, and contracts find their way either directly or indirectly into the European market. Some time ago it was decided to proceed with the electrification of the Northern Nile Delta for drainage and irrigation purposes, and the contract in connection with the scheme has recently been placed with Messrs. Siemens Bros. and Co., Ltd.

The contract, which involves a sum of £559,192, is to supply, on the site, all the material, parts, and equipment for a three-phase circuit of about 60,000 volts, and includes power stations, overhead transmission line, towers, high-tension insulators, earth conductors, submarine cables, switches, and all other parts and accessories necessary. In connection with this scheme 15 electrically driven pumping stations are to be erected, and tenders are being invited for the construction of these stations. In addition to this scheme for the Northern Delta of the Nile another comprehensive scheme of irrigation is proposed for the isolated basins in Upper Egypt, bordering on the Sudan. Another series of electrical pumping stations will be required for this scheme. It is to be hoped that British firms will also be successful in securing the contracts for the proposed work and so give a much-needed impetus to industry in this country.

Transactions of the Institution of Engineers and Shipbuilders of Scotland.

Volume LXXIII., Part VI., of these transactions contains a copy of three papers, together with the discussions resulting from them, and also a discussion on Mr. H. A. D. Acland's paper, which was published in the last part of the transactions, on the "Kitson-Still Locomotive." It is apparent that the internal-combustion locomotive is gradually developing in such size and power as to be seriously considered as a hauling unit for main-line working in the near future. The paper on "Higher Steam Pressures for Power Generation" by the American engineers, Messrs. F. E. Moultrop and M. D. Engle, indicates the progress being made with high steam pressures. It is evident that the use of steam at pressures above 1,000 lb. has passed from the experimental stage into a period of intensive development and exploitation. Many problems have already been met and solved, and the commercial possibilities of higher steam pressures have been demonstrated. Marine casualties are considered by Mr. J. W. W. Drysdale in his paper on "Marine Salvage Pumping."

Practically every industry turns to the engineer and seeks his aid in securing greater production. In view of this it is important that engineers should be constantly studying their methods of production with a view to eliminating all possible waste and sources of inefficiency, and Mr. Kenneth M. Sloan considers this in a paper entitled "Remedies for Some Engineering Workshop Inefficiencies." The discussions on the papers are full of interest.

New Installations for Steamers.

A contract has been placed with Messrs. William Beardmore and Co., Ltd., Dalmuir, by the Clan Line for the manufacture and installation of exhaust-steam turbines in seven of their large vessels.

The system consists in utilising the energy remaining in the exhaust steam, after its exit from the main engine, in a fast-running steam turbine, the power from which is delivered to the main propeller shaft by means of a clutch and reduction gearing.

This work forms one of the largest single group of orders yet placed for such reconstruction installations.

"Durapso" Steel.

A French concern, the Société des Acieries de Pompey, has recently introduced a new steel known as "Durapso," which is claimed to be specially suitable for the construction of electric power transmission-line masts and the structural work of outdoor transformer stations. As compared with mild steel, it is claimed that it is possible to effect a reduction of from 20 to 30% in the weight of material used for a particular job, while in the case of masts another feature claimed for the new steel is its freedom from rusting and corrosion tendencies, repeated tests having shown it to be "twelve times less attackable" in this respect than ordinary steel.

Review of Current Literature.

FUEL ECONOMY REVIEW.

THE "Annual Fuel Economy Review" for 1930, just published, contains some very interesting information on the many aspects of fuel economy, particularly in regard to rationalisation of fuel purchase, industrial tariffs for electricity, boiler-house record sheets, and smoke abatement.

This annual publication is an attempt on the part of the F.B.I. to secure improved fuel practice by the dissemination of up-to-date information on fuel preparation and utilisation. Coal is not only apparently on a permanently higher price level, but further increases are almost certain in the near future. Fuel cost is thus becoming an increasingly important item in the total production costs, and unless every effort is made to secure the most efficient utilisation of fuel, British industry stands to be definitely handicapped in world markets. The review is addressed primarily to boiler-house engineers and heating and power executives. Its scope is necessarily wide, as it is felt that, however efficient a particular plant may be for a particular purpose, further economies may sometimes be possible by a complete change of plant and fuel. Accordingly, the review concerns itself with gas, electricity and oil, in addition to coal, and also with developments in fuel practice.

The purchase of coal on a calorific basis, which has already been adopted in this country to a limited extent, offers definite advantages to consumers. As far as practical application has been tried, sufficient proof has been demonstrated that purchase on a calorific value is capable of fulfilment and has given satisfaction both to the purchaser and supplier. This method of purchase is, after all, a logical development in line with current industrial development, where the tendency is to secure the greatest possible economic control over all materials and processes.

In regard to electricity tariffs, to which special attention is directed, there is in many quarters a lack of knowledge of electricity supply, both in relation to nomenclature and to the basis on which electricity is sold. This lack of knowledge is a definite bar to the progress of electrification. In view of this a considerable part of the matter dealing with the subject is devoted to a description of the supply system and its characteristics.

Systematic records of plant operation are of first importance in the attainment and maintenance of a high level of operating efficiency. Records for normal-sized industrial plants, requiring the minimum of compilation and equipment, are dealt with in this review.

In view of the considerable attention devoted to smoke abatement during recent years, an article on American methods of dealing with the smoke nuisance will be of great interest. An article on "Methods and Standards of Smoke Measurement," detailing experimental work on smoke observation carried out at the Fuel Research Station, will also prove of considerable interest, both to industrial engineers, to Health Authorities, and to others who deal with the smoke problem.

Among the many articles in this review is an interesting and informative article on "Industrial Furnaces," and as it would be impossible to consider fully a subject of such magnitude in the few pages given to it, the article has been confined to those industrial furnaces which function at moderate temperatures.

This review is worthy of earnest thought, and is obtainable from Federation of British Industries, 39, St. James's Street, London, S.W. 1. Price 2s. 6d.

New depots have been opened by Metropolitan-Vickers Electrical Co., Ltd., for the sale of their "Cosmos" lamps in Glasgow and Birmingham districts. In the case of Glasgow the company's meter business will be conducted from the same address, 177, West George Street, Glasgow. In the Birmingham area from International Exchange Buildings, Edmund Street, Birmingham.

British Standard Specifications.

THE British Engineering Standards Association have issued revisions of British Standard Specifications Nos. 126 and 127 for flameproof air-break switches, with or without fuses, and for flameproof air-break circuit breakers. These specifications, which are suitable for use with A.C. and D.C. voltages not exceeding 660 volts, have been reviewed by the Colliery Committees of the Association with a view to making them suitable for the latest requirements of the coal-mining industry in this country. Provisions are included dealing with design, construction, rating, sizes, and marking. The question of tests is fully dealt with; type tests being laid down for mechanical strength, breaking capacity, flameproofness, and temperature rise, while special dielectric and performance tests are also incorporated.

A useful addition has been made to the specifications by the inclusion, in the form of an appendix, of some notes on the problems of flameproof enclosure, which have been based upon the reports of the Safety in Mines Research Board, which are inserted for the information and guidance of purchasers and users rather than for the instruction of manufacturers.

The British Engineering Standards Association have also issued a revised edition of British Standard Specifica- No. 102 for Tramway Axles. The new issue has been enlarged and now contains separate specifications for axles of three different qualities of material. This extension has been made in view of the increasing tendency amongst some engineers to adopt axles with a somewhat higher tensile strength, and this demand has been met by providing for axles of high-tensile carbon steel and nickel-chrome steel. The specification, as revised, will now meet the requirements of all tramway undertakings. The opportunity has also been taken to make certain changes so as to bring the original specification more into line with present-day requirements.

Copies of these specifications can be obtained from the British Engineering Standards Association, Publications Dept., 28, Victoria Street, Westminster, S.W. 1, price 2s. 2d. each post free.

Royal Aeronautical Society.

AT their meeting on June 24, 1930, the Council of the Royal Aeronautical Society unanimously elected Mr. C. R. Fairey, M.B.E., F.R.A.S., as President Designate. Mr. Fairey will assume office at the end of September, 1930, when the presidency is vacated by the Master of Sempill.

It will be recalled that the Master of Sempill was elected chairman of the Society in June, 1926, and took office in October, 1926. He was re-elected for the year 1927-8, and early during this period arrangements were made whereby the Institution of Aeronautical Engineers became incorporated with the Royal Aeronautical Society, and the Master of Sempill was elected to serve as the first President of the Society under the new rules, which abolished the office of chairman and considerably altered the duties of the President. The Master of Sempill has continuously filled the office of President from that time, and is now not eligible for re-election.

At the same meeting the three existing vice-presidents were re-elected for 1930-31, Air-Vice-Marshal Sir Vyell Vyvyan, K.C.B., D.S.O., Lieut.-Col. J. T. C. Moore-Brabazon, M.C., F.R.A.S., and Mr. H. E. Wimperis, C.B.E., F.R.A.S., Director of Scientific Research. Professor L. Bairstow, C.B.E., F.R.A.S., was elected an additional vice-president for the same period.

The Churchill Machine Tool Co., Ltd., Broadheath, Manchester.

The advertisement by this company in our June issue did not carry the usual reference to their connection with the Associated British Machine Tool Makers, Ltd., of which, of course, the Churchill Machine Tool Co., Ltd., are members, and for whom they act as overseas selling agents.

Some Recent Inventions.

ELECTRIC FURNACE IMPROVEMENTS.

The illustration, Fig. 1, shows the general arrangement of an improved electric furnace of the rotary or rotating drum type as used for the annealing or other heat-treatment of small metal products. The improved construction is adapted to operate on continuous recuperative principles by enabling an exchange of heat between hot work conveyed from the treatment region to work which is being carried to this region. In construction it is more convenient than a previously designed furnace of this type, as it reduces the

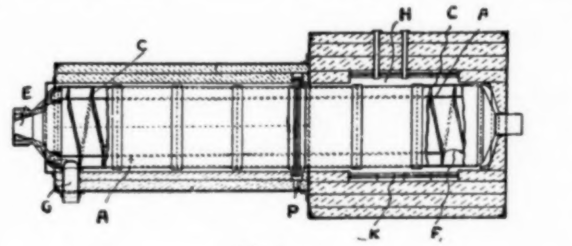


Fig. 1.

weight of the rotating parts and affords easier access to the interior of the furnace chamber. In its present form the furnace is more highly developed, giving better facilities for inspection and also for the replacement of the resistance elements.

The improved furnace consists of a rotary conveyer, which is enclosed partly in a stationary insulating casing, and partly in the stationary heating chamber of a furnace structure, which is normally secured to the insulating casing, but can be readily separated and removed clear from the conveyer to give access to the heating chamber. The conveyer is so constructed that when it is rotated relative to the stationary heater the work is conveyed through the heated end of the furnace and transferred to another compartment, from which it is conveyed to the discharge aperture. The structure is indicated more clearly in Fig. 2, which shows an enlarged view of the charging end of the furnace. It will be noted that the inner work conveyer cylinder A and the annular space B between the inner and outer cylinders A and C are provided with conveyer blades of opposite pitch; these are so arranged that the work in one chamber is conveyed in an opposite direction in the discharge chamber.

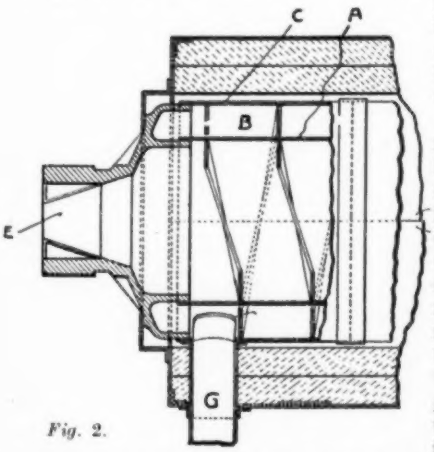


Fig. 2.

The work is received at the feed hopper E and is carried forward by the conveyer blades of the inner cylinder A to the resistance heated region H, when the heat-treated work falls by gravity through the aperture F into the outer chamber, and is returned to the feed end to be discharged through the opening G. During the return flow the heated work moves in contact with the walls of the inner cylinder containing relatively cold work, and, as the inner cylinder is made of heat-conducting metal, heat is absorbed by the incoming work during its travel towards the resistance-heated region.

The heater elements K of the stationary part of the furnace are arranged in the heating chamber H, and in order that the rotating conveyer and its load will have adequate support the charging end E is carried in a system of bearings, while the heater end has a trunnion that extends through an aperture in the end of the heater casing and is supported by external bearings. Intermediate bearings are provided at P, and these, together with the hopper end bearings, serve to support the conveyer when the heater-end trunnion is left unsupported by withdrawal of the furnace.

324,609. Birmingham Electric Furnace Ltd. and A. G. Lobley, patentees. Arthur Saddler, agent, 44, Waterloo Street, Birmingham. January 30, 1930.

MEANS OF MEASURING THE PERMEABILITY OF SANDS.

The advisability of determining to what extent resistance is offered against the proper escape of gases from sand moulds is obvious. One of the important factors that render sand of special value for this purpose is its permeability, and as different grades, as well as different compositions, of sand have varying degrees of permeability, production on a scientific basis can only progress adequately

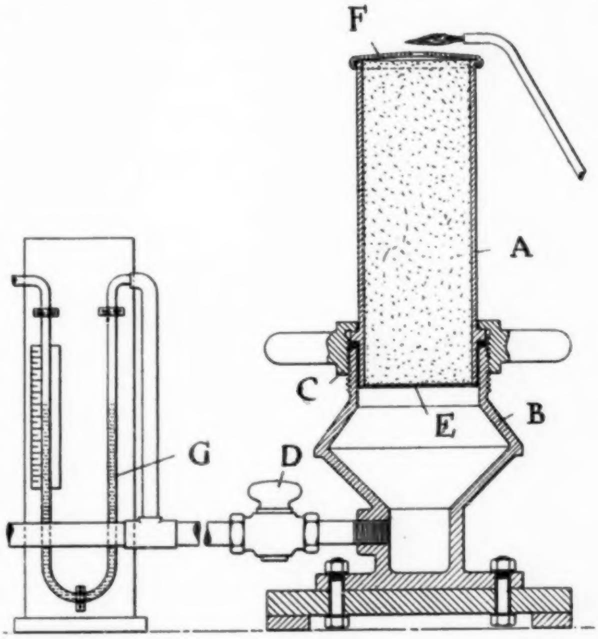


Fig. 1.

when a measure of the degree of permeability is readily obtainable. Many devices have been and are being used for this purpose. A more recent appliance which facilitates comparisons in permeability between different sands is illustrated in Fig. 1. It comprises the combination of a sand container and a gas chamber, together with means for measuring the pressure of gas in the chamber, and means for igniting the gas issuing from the sand.

As is indicated in the illustration the cylinder A contains the sample of sand rammed to a standard density. It is secured vertically over a hollow base B, which forms a gas chamber into which coal gas or any other combustible gas can be admitted through a suitable tap D. A gas-tight connection between the lower end of the container and the open top of the gas chamber is formed by a screwed union C. A perforated plate or wire gauze is preferable at E to ensure a uniform distribution of the gas passing from the chamber into the sand. A restricted outlet at the top of the cylinder is secured by means of cap F, and a pilot flame is arranged over this outlet to ignite escaping gas. A manometer G, which may be of any convenient form, is connected to the

gas supply, near the gas chamber, for measuring the gas pressure.

When the sample of sand has been rammed in the container, and the latter is secured in position over the gas chamber, gas at a specified pressure is admitted to the chamber, and the time taken between the turning-on of the gas and its ignition on passing through the sand is taken as a measure of the permeability of the sample of sand. This apparatus provides an effective means for measuring, in a comparative sense, the degree of permeability of sand, but it is important to ram the samples to a regular and similar density so that each measure will have its proper comparative value.

327,306. THE BRITISH CAST-IRON RESEARCH ASSOCIATION, W. J. REES, and J. G. A. SKERL, patentees. April 3, 1930.

IMPROVEMENTS IN MOULDING MACHINES.

IN the usual type of pressure-moulding machine the operations comprise the lifting of the pattern or the moulding box, or both of them, for the purpose of pressing the sand into the mould, and the further operation of lifting either the pattern or the box alone during the time of stripping. An improved arrangement has been devised for separating the pattern from the mould, in which part of

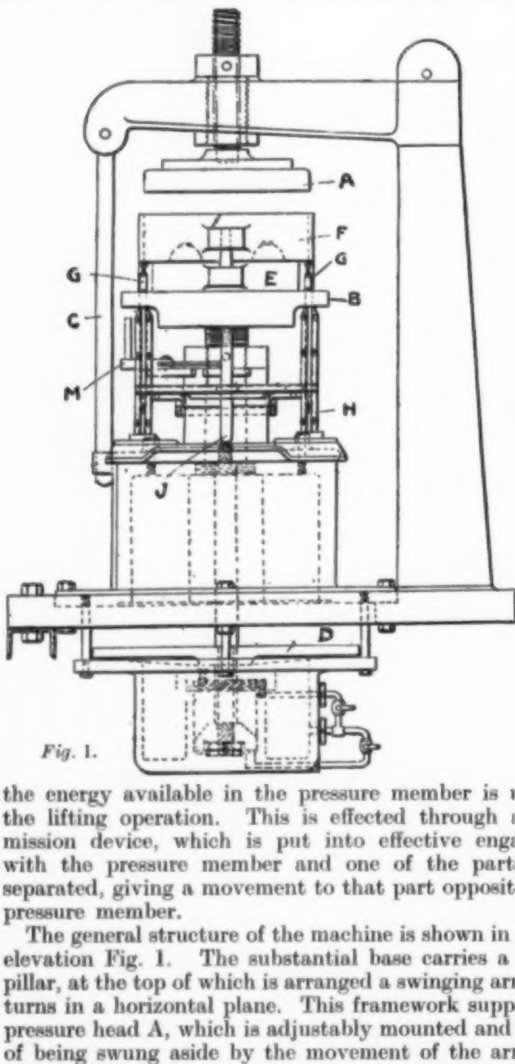


Fig. 1.

the energy available in the pressure member is used for the lifting operation. This is effected through a transmission device, which is put into effective engagement with the pressure member and one of the parts to be separated, giving a movement to that part opposite to the pressure member.

The general structure of the machine is shown in the side elevation Fig. 1. The substantial base carries a vertical pillar, at the top of which is arranged a swinging arm which turns in a horizontal plane. This framework supports the pressure head A, which is adjustably mounted and capable of being swung aside by the movement of the arm. The base, which carries an electro-magnet, supports and guides the pressure-applying member B, which is accentuated by the electro-magnet. The arm is partly supported and held in position by the tie-rod C. When the machine is not under pressure this rod can be swung clear and the arm moved, carrying the presser-head clear of the mould.

The electro-magnet acts upon the armature D, raising it from the position shown in Fig. 1 when making a mould. After the pressing is complete the electro-magnet is de-energised and the pressure-plate B falls back, carrying with it the pattern-plate E and the moulding-box F to the position of rest. The lifting stools G have projecting pins which rest on the plate B. At their lower ends these stools have catches projecting through slots in the pillars H. With this arrangement the stools move up and down with the plate B when no obstructions are placed in the paths of catches. Obstructions can be provided by bars carried on swinging levers as shown in Figs. 2 and 3. The levers J are normally held in position by the rods K, which work on slides and are controlled by a handle M. The procedure for separating the mould from the pattern is to raise the pressure-plate B a second time, operate the handle M, and then allow the pressure-plate to descend. At this second descent the levers J operate to lift the bars, which then lie under the catches attached to the lifting stools. Thus, the stools take with them the mould, and by this means it is possible to obtain a considerable separation movement between the pattern and mould, which is essential for deep lifts. Further, the extent of the lift can be adjusted.

The preceding description refers more particularly to the moulding procedure, in which the pattern-plate and moulding-box are lifted together. When dealing with the case of down-sand frame moulding, in which the moulding-box is placed in contact with the presser-head, and the extra sand is placed below the box and between it and the pattern-plate, being enclosed by a frame called the down-sand frame, a somewhat different arrangement is necessary in order to obtain appropriate separating action. The modification is indicated in Fig. 4. In this case the pattern-plate G, as before, rests on the pressure-plate B; the moulding-box F is, however, placed in contact with the presser-head A, and the space between this box and the pattern-plate is enclosed by the down-sand frame N. This frame has laterally projecting lugs through which it is carried by pillars O, the lower ends of which are mounted on housing A. The stools G terminate at their upper ends in swivel angle brackets, which can either stand in the position shown in Fig. 4, where their upper ends are under lugs on the moulding-box F, or can be swung about the ends of the stools horizontally so as to lie clear of the moulding-box. They occupy the latter position during the pressing operation, in which the pattern-plate is moved up through the distance indicated by P. This completes the making of the mould, after which the pressure-plate B and the pattern-plate G descend to the position shown in Fig. 4, the moulding-box being sustained by the down-sand frame N and the pillars O. The swivel angle brackets are then swung into the position shown, and the presser-head is swung aside. The next upward movement of the plate B with the pattern-plate G carries the moulding-box up with it, the pattern thus being prevented from coming into contact with the sand for a second time.

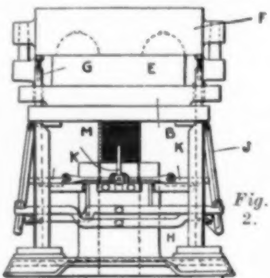


Fig. 2.

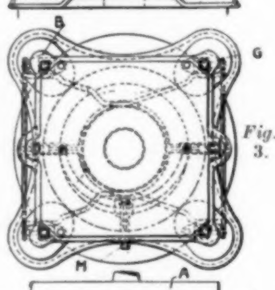


Fig. 3.

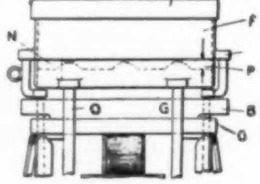


Fig. 4.

325,453. BRITISH INSULATED CABLES Co. and T. W. BULLOCK, patentees. R. L. Cleaver, agent, Imperial House, Kingsway, W.C. 2. February 20, 1930.

IRON AND STEEL REPORT.

A somewhat surprising development in the foundry iron market was the decision of the Central (Midland) Iron Producers' Association, at a special meeting in the second week of July, to reduce quotations by 2s. 6d. per ton, bringing prices for delivery to users in the Manchester zone to 74s. 6d. for both Staffordshire and Derbyshire brands. This move was surprising if for no other reason than that the month-end meeting of the Association in June had passed without any action being taken, and it is at the monthly meetings that price decisions are usually made.

At the moment of writing it is too early to judge of the effect of this latest step on the movement of pig iron. In virtually all consuming centres—Lancashire, the Midlands, the North east Coast, and Clydeside, the two former the chief outlets for Derbyshire and Staffordshire brands - sales for some time have been on a much reduced scale. It has not merely been that consumers have been holding their hands in the hope of being able to get in at more favourable rates, though this undoubtedly has been a potent factor. The truth of the matter is that foundries in most centres, except in certain speciality lines, have been engaged at much below capacity, and short-time operations have been fairly general. The result has been a marked curtailment of buying, and only the few more favourably situated concerns have had any inducement to place orders for pig iron much in advance of about a month.

If the reduction has been made solely in the hope of expanding consumption, it is not improbable that, in the absence of a marked improvement in the state of foundry order books, the move will be doomed to disappointment. Possibly, however, in view of the fact that the fuel situation has been appreciably easier during the last few months from the point of view of pig-iron production costs, it has been decided to pass on part at least of the benefits to the users, and it is a move that the latter will appreciate. Fortunately for some of the principal producers of foundry iron, good pipe contracts which they hold have served to absorb a substantial portion of the make, over and above outside sales, otherwise aggregate stocks of pig iron at the furnaces would have been substantially heavier in the aggregate than they actually are.

In respect of manufactured iron, makers of common bars are experiencing a difficult time, and current orders in this section continue on a very modest scale, users restricting their commitments to little more than immediate requirements. Marked bars, however, are reported from some centres to be meeting with a fairly active demand, and producing mills are operating at a reasonably satisfactory rate.

The demand for steel, taking the position generally, is anything but good, although in most lines there has been no change in the price situation. There has, however, been weakness in evidence in the case of small bars, and supplies of these are now readily obtainable at from £7 15s. to £8 per ton. Boiler plates, also, are on a somewhat lower basis, acid and basic quantities being quoted at down to about £9 15s. Frame and tank plates, joists and sections, and large bars have been maintained at the schedule prices. There are prospects of more active conditions in shipbuilding, particularly on the Clyde, but there is no indication of improvement yet in the demand for constructional engineering qualities. Locomotive-building firms during the month under review have been specifying for fair quantities, but rollers continue to get comparatively little support from such branches as textile-machinery manufacture and boiler making, and almost immediate delivery of most descriptions of steel is being offered.

We have been informed that practically the whole of the issued shares of Alloy Welding Porcesses, Ltd., of Ferry Lane, Walthamstow, E.17, have been purchased by Messrs. Murex, Limited.

NON-FERROUS REPORT.

The prices of non-ferrous metals are unstable. The industries responsible for their consumption are not very active, and the market conditions cause buyers to adhere to the policy of avoiding the risk of over-estimating their requirements and adopting any means to this end. It is difficult to determine the real cause of the continued weakness of copper in America, but forced realisations are suspected. Electrolytic copper is pursuing the downward course with the standard, and the fall since Marc hhas been considerable. Production has been reduced as a result of the conditions, last month's daily output being the lowest for the year. The changes in the prices of copper manufactured articles are almost negligible.

The secretaries of the Tin Shareholders' Association have issued a statement as to the objects of the Association. They state that "In view of the uninformative figures which are published by the majority of companies with regard to production costs, one important aim is to call for more detailed figures which give the actual cost of placing the metal on the market. Shareholders will be able to judge whether the product is being sold at an economic price, yielding a fair profit on their investment, or whether the output should be held up for sale later when markets improve."

A further aim of the Association is to secure a greater measure of co-operation between the individual companies for the common good of the industry as a whole. That involves agitation for the exchange and pooling of technical information, support for a Central Research Bureau, and an agitation for the adoption of the latest methods of research and propaganda, aimed at the wider use of tin and the winder distribution of products of all kinds in which tin is used.

Endeavours to control the output have had so little effect thus far in restoring the balance that confidence is lacking. The Malayan Chamber of Mines is now co-operating in the movement to suspend working long enough to enable consumptive demand to overtake supply, but if equilibrium is to be maintained something more than that is necessary. It is reported that one Chinese mine is being stopped altogether until tin can be sold at a price which will return a reasonable profit. In regard to the galvanisers they are passing through a very lean time, and the brass trade, which is the next biggest consumer, is very dull also.

Catalogues and Other Publications.

An A.W.P. Bulletin, No. Co., has been issued in which special reference is made to the application of special alloying electrodes for the welding of corrosion and heat-resisting steels and alloys. Considerable progress has been made during recent years in the use of stainless and heat-resisting steels, and the various alloys used have all presented welding problems; special electrodes, however, can now be manufactured to suit any proprietary make of steel.

We have received a copy of the *Welder* which, we understand, is to be converted from a bi-monthly to a monthly magazine devoted to electric-arc and oxy-acetylene welding. The July issue contains many interesting articles, two of which have a controversial interest as they deal with the connection between the welding and foundry industries from the two angles represented by these industries. A copy of these publications will be sent to those interested on application to Alloy Welding Processes, Ltd., Ferry Lane Works, London, E. 17.

The *Nickel Bulletin* for June contains a very informative article on the use of nickel alloys in aircraft engine design. In aircraft engines lightness, combined with rigidity, can be met by using either light alloys or high-tensile steels, but when consistent reliability, resistance to fatigue, and dynamic stress are of first importance, high-tensile steels are specified. Another article deals with Monel metal condenser tubes, and, together with the usual features, this issue is comparable with any of its predecessors. Copies are available on application to the Bureau of Information on Nickel, The Mond Nickel Co., Ltd., Imperial Chemical House, London, S.W. 1.

MARKET PRICES

ALUMINIUM.

99% Purity		£95 0 0
Castings, 2.L5 Alloy	lb.	1/3–1/8
„ 2.L8 „	„	1/4–1/9
„ Silicon „	„	—

ANTIMONY.

English	£38 0 0
Chinese	26 0 0
Crude	20 0 0

BRASS.

Solid Drawn Tubes	lb.	10¾d.
Brazed Tubes	lb.	12¾d.
Rods Drawn	„	10¾d.
Wire	„	9½d.
*Extruded Brass Bars	„	5¾d.

COPPER.

Standard Cash		£47 15 0
Electrolytic		53 10 0
Best Selected		54 5 0
Tough		53 15 0
Sheets		83 0 0
Wire Bars		56 16 0
Ingot Bars		56 16 3
Solid Drawn Tubes	lb.	12d.
Brazed Tubes	„	12d.

FERRO ALLOYS.

‡Tungsten Metal Powder	lb.	£0 2 10½
‡Ferro Tungsten	„	0 2 7½
§Ferro Chrome, 60-70% Chr. Basis 60% Chr. 2-ton lots or up.		
2-4% Carbon, scale 11/- per unit	ton	30 15 0
4-6% Carbon, scale 7/- per unit	„	23 7 6
6-8% Carbon, scale 7/- per unit	„	22 12 6
8-10% Carbon, scale 7/- per unit	„	22 0 0
§Ferro Chrome, Specially Refined, broken in small pieces for Crucible Steel-work. Quantities of 1 ton or over. Basis 60% Ch. Guar. max. 2% Carbon, scale 10/- per unit	„	33 12 6
§Guar. max. 1% Carbon, scale 13/6 per unit	„	38 2 6
§Guar. max. 0.7% Carbon, scale 15/- per unit	„	39 15 0
‡Manganese Metal 96-98% Mn.	lb.	0 1 3
‡Metallic Chromium	„	0 2 7
§Ferro-Vanadium 25-50%	„	0 12 9
§Spiegel, 18-20%	ton	7 5 0
Ferro Silicon—		
Basis 10%, scale 3/- per unit	ton	5 17 6
‖20/30% basis 25%, scale 3/- per unit	„	6 16 0
‖45/50% basis 45%, scale 5/- per unit	„	10 17 6
‖70/80% basis 75%, scale 6/- per unit	„	17 10 0
‖90/95% basis 90%, scale 10/- per unit	„	25 6 0
§Silico Manganese 65/75% Mn., basis 65% Mn.	„	14 0 0
§Ferro-Carbon Titanium, 15/18% Ti	lb.	0 0 6
§Ferro Phosphorus, 20-25%	ton	16 0 0

FUELS.

Foundry Coke—	
S. Wales Export	£1 7 0 to £1 17 0
Sheffield „	0 17 0 „ 0 18 6
Durham	1 4 0 to 1 8 0
Furnace Coke—	
Sheffield Export	£0 17 0 to £0 18 6
S. Wales „	1 1 0 to 1 1 6
Blast-Furnace Coke, at ovens	0 15 6

GUN METAL.

Commercial Ingots		£71 0 0
*Gunmetal Bars, Tank brand, 1 in. dia. and upwards	lb.	0 1 0
*Cored Bars	„	0 1 2

LEAD.

Soft Foreign	£18 2 6
English	19 10 0

MANUFACTURED IRON.

Scotland—	
Crown Bars	£10 5 0
N.E. Coast—	
Rivets	11 10 0
Best Bars	11 5 0
Common Bars	10 15 0
Lancashire—	
Crown Bars	10 5 0
Hoops	13 0 0
Midlands—	
Crown Bars	10 7 6
Marked Bars	12 10 0
Unmarked Bars	—
Nut and Bolt Bars	9 2 6
Gas Strip	11 2 6
S. Yorks.—	
Best Bars	11 10 0
Hoops	12 0 0

PHOSPHOR BRONZE.

*Bars, Tank brand, 1 in. dia. and upwards	lb.	1/-
*Cored Bars	„	1/2
†Strip	„	1/1
†Sheet to 10 W.G.	„	1/2
†Wire	„	1/2½
†Rods	„	1/2
†Tubes	„	1/6
†Castings	„	1/2

†10% Phos. Cop. £30 above B.S.
†15% Phos. Cop. £35 above B.S.
†Phos. Tin (5%) £30 above English Ingots.

PIG IRON.

Scotland—	
Hematite M/Nos.	£3 19 6
Foundry No. 1	3 19 0
„ No. 3	3 16 6
N.E. Coast—	
Hematite No. 1	3 11 6
Foundry No. 1	3 10 0
„ No. 3	3 7 6
„ No. 4	3 6 6
Cleveland—	
Foundry No. 3	3 7 6
„ No. 4	3 6 6
Silicon Iron	3 15 0
Forge No. 4	3 6 0
N.W. Coast—	
Hematite	4 10 6
Midlands—	
N. Staffs Forge No. 4	3 13 6
„ Foundry No. 3	3 18 6
Northants—	
Forge No. 4	3 10 0
Foundry No. 3	3 15 0
Derbyshire Forge	3 13 6
„ Foundry No. 3	3 18 6
West Coast Hematite	4 8 0
East „ „	4 6 0

SWEDISH CHARCOAL IRON AND STEEL.

Pig Iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 „ £18 10 0
Blooms	£10 0 0 „ £12 0 0
Keg steel	£32 0 0 „ £33 0 0
Faggot steel	£20 0 0 „ £24 0 0

All per English ton, f.o.b. Gothenburg.

SCRAP METAL.

Copper Clean	£43 0 0
„ Braziery	40 0 0
„ Wire	—
Brass	32 0 0
Gun Metal	42 0 0
Zinc	9 0 0
Aluminium Cuttings	60 0 0
Lead	15 10 0
Heavy Steel—	
S. Wales	2 16 0
Scotland	2 12 0
Cleveland	2 10 0
Cast Iron—	
Lancashire	3 0 0
S. Wales	2 15 0
Cleveland	2 17 6
Steel Turnings—	
Cleveland	2 4 0
Lancashire	1 8 0
Cast Iron Borings—	
Cleveland	2 0 0
Scotland	2 0 0

SPELTER.

G.O.B. Official	—
Hard	£12 0 0
English	16 2 6
India	14 5 0
Re-melted	14 15 0

STEEL.

Ship, Bridge, and Tank Plates—	
Scotland	£8 15 0
North-East Coast	8 15 0
Midlands	8 17 6
Boiler Plates (Land), Scotland	10 0 0
„ „ (Marine) „	10 10 0
„ „ (Land), N.E. Coast	10 0 0
„ „ (Marine) „	10 10 0
Angles, Scotland	8 7 6
„ North-East Coast	8 7 6
„ Midlands	8 7 6
Joists	8 10 0
Heavy Rails	8 10 0
Fishplates	12 0 0
Light Rails	8 17 6
Sheffield—	
Siemens Acid Billets	9 10 0
Hard Basic	9 12 6
Medium Basic	8 2 6
Soft Basic	6 10 0
Hoops	9 15 0
Manchester—	
Hoops	9 15 0
Scotland, Sheets 20 W.G.	9 10 0

HIGH SPEED TOOL STEEL.

Finished Bars 18% Tungsten	lb.	3/-
Round and Squares, ½ in. to ¼ in.	„	3d.
Under ¼ in. to $\frac{3}{16}$ in.	„	1/-
Round and Squares 3 in.	„	4d.
Flats under 1 in. × ⅜ in.	„	3d.
„ „ ½ in. × ¼ in.	„	3d.

TIN.

Standard Cash	£133 7 6
English	134 5 0
Australian	134 12 6
Eastern	136 15 0
Tin Plates I.C. 20 × 14 box	18/3
Block Tin Cash	£134 7 6

ZINC.

English Sheets	£27 0 0
Rods	30 0 0
Battery Plates	24 10 0

* McKechnie Brothers, Ltd., quoted July 7. † C. Clifford & Son, Ltd., quoted July 7. ‡ Murex Limited, quoted July 7.

Pearson & Knowles' Current Basis Prices:—Wrought Iron Bars, £10 5s. 0d.; Mild Steel Bars, £7 17s. 6d.; Wrought Iron Hoops, £12; Best Special Steel Baling Hoops, £9 15s. 0d.; Soft Steel Hoops (Coopers' and Ordinary Qualities), £9; C.R. & C.A. Steel Hoops, £12 10s. 0d. to £13 10s. 0d.; "Iris" Bars, £8 15s. 0d. All Nett Cash.

‖ R. Hostombe, quoted July 7. Delivery c.i.f., suitable U.K. ports. § Prices quoted July 7, ex warehouse